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AGRICULTURAL ENGINEERING

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# The Mountain Meeting

THAT agricultural engineers will survey the pattern of their field this year from the snow line of Estes Park is more than symbolic.

Rare, pure mountain air, high above the murk and muddle of daily preoccupation, has been known and used for ages as an ideal medium for thoughtful concentration.

Given this advantage of geographic elevation, the program and local arrangements committees have set about to bring the meeting likewise to new high levels of value to individuals attending and to the composite of those individuals—our branch of the engineering profession.

They have sought out and marked with authoritative papers current critical points in the agricultural engineering field.

They have asked speakers to focus attention on their assigned points with telescopic directness.

They have prepared to complement the view presented by each speaker with the perspective of discussion, formal and informal. They have allowed time for discussion and taken steps to encourage it.

In location, subject matter, plan and presentation; with consideration for every means of propounding and every factor in reception, this meeting is designed to produce a maximum exchange of ideas and information on the most timely subjects before agricultural engineers.

The characteristics of the Society, the wishes of its members, and the purposes of its meetings have been considered. Vicarious participation will be minimized and opportunity for active contribution to the group thought will be multiplied.

The effect—a beehive of mental give and take, redirected and prodded into new intensity at intervals by formal sessions bringing a riveting-hammer staccato of information and ideas, from knowing sources, directed at critical points, within easy eye and ear range of all present.

The result—a maximum exchange of thought on important points; in a minimum length of meeting; a maximum freedom for individuals to pursue their particular interests; a minimum waste of their time. An alternately intensive and extensive cultivation of professional minds. A meeting, fruitful but uncrowded.

Thus planned and executed, the 30th annual meeting of the American Society of Agricultural Engineers this year will more than ever justify attendance in tangible benefits to those who are in agricultural engineering work to make the most of it and of themselves.

# What Is Waste?

REFLECTIVE reading of the paper by Jefferson B. Rodgers on briquettes, appearing elsewhere in these pages, seems to call for comment, some of which should have been made long ago. We have in mind mainly the use of the word "waste" for straw, cornstalks and cobs, oat hulls, etc. While such materials may be waste from the standpoint of an immediate feeding or marketing operation, we suspect that our colleagues in the realms of agronomy and agricultural chemistry have been challenging the soundness of our easy classification of these materials as wastes. If we were to strike a chemical balance of the soil or of the farm as a whole, we might recognize "wastes" in an entirely different sense.

On the one hand we are working for soil conservation, striving to maintain or augment the chemical constituency of the soil in critical elements, also its physical content of material which may serve as carriers for the chemical elements, for biological activity, and for the mechanical processes of tillage and better behavior under erosive influences. We submit that no farm crop material should be classed as a waste unless it is harmful or worthless for aiding any of these objectives; or at least is uneconomic as a means toward their attainment. On the other hand, we are seeking uses for various of these materials which will give them a more direct and a higher economic value. This is to be desired, but any such gain should be stated as the advance over the value of the material for soil conservation purposes. It is an alternative use, not the salvage of a true waste.

On the face of the figures cited, briquetting of straw, etc., would appear to be an economic source of satisfactory fuel for farm use, not only in heating the farm home, but in crop drying or other thermal operations. So used, there need be little or no loss of the potassium, phosphorus, and other nonvolatile elements. Be it said in passing that the list of critical elements seems due to be enlarged in the case of intensive cultivation of old—and some not so old—soils. If the cropping system affords a surplus of nitrogen fixation and humus formation, there would seem no objection, from the conservation standpoint, to the extensive use of farm by-product fuels. Of course, there is nothing new in the prospect to those who have burned twisted hay in an airtight stove, or stoked a straw-burning threshing engine.

The somewhat meager tests on briquetting of alfalfa suggest another type of waste—that of storage space and transportation capacity in the traditional management of forage feeds. In some cases the cost of bags or other containers should be accounted among the wastes. To be sure, the matter of briquetting costs cannot be taken too lightly. The per-ton costs cited apparently do not include investment charges, and the investment presumably is high. Power charges are at a rate lower than is commonly available for farm power. If the present trends toward lower interest rates continue, both these cost elements may be reduced, but so also will comparable charges for alternative methods. Portability of the machinery, or its alternative, transportation of the material, are important questions.

Nevertheless, with the improvements that may be expected, briquetting deserves a place in the thinking of the profession as a means toward the industrial consumption of cellulose crops as well as a method of feed processing and a source of farm fuel.

# Fire Resistance for Farm Homes

TWO DEVELOPMENTS described in short papers elsewhere in this issue add their contributions toward a greater degree of fire-safety, and it seems significant that they, along with other modern developments, embody more or less of the factory-built principle. The steel-clad house, as described, embodies conventional wood framing, and may also employ ordinary lumber for insulation, but faces the wood both inside and outside with steel sheets which are well-nigh perfect protection against both lightning and stray sparks or small brands. The wood so confined between incombustible, impervious sheets should be relatively slow burning, and relatively resistant to ignition by radiant heat. While it could not be called fireproof—and few constructions can be truly so called—it would seem to reduce the human hazards to a far lower point than has been deemed possible at so low a construction cost.

The other development, with scarcely a feature in common, also is fire resistant as described. The steel framing, shielded by gypsum panels on the inside and by brick outside, affords a degree of inherent lightning protection which could easily be made complete, and the insulation, whether the cork as mentioned, wood, or some other material, is so shielded as to be difficult of ignition, slow burning, and of low hazard to human life if it does burn.

To complete the list of later contributions, we should mention once more the precast joists of both concrete and tile, and the slab floors of which they are designed to be part and foundation. All of these developments are claimed by their sponsors to be competitive in cost with older styles of construction, or so nearly so that only a little value need be assigned to greater safety, better insulation, or lower maintenance. We suggest as a worthy field for the resourcefulness of farm structures engineers the more perfect correlation and combination of these new developments. It is easily conceivable that their more or less complete assembly into manufactured units may bring the total cost of a building actually below that of conventional construction, and at the same time offer a high degree of all-around fire safety.

# The Public Patent Problem

THOSE who heard the original presentation of the paper on patents by G. D. Jones, and particularly the spirited discussion which followed it, know that the issue of how to administer the patents arising from public research is much more important and perplexing than might be inferred from its dispassionate mention by Mr. Jones. We do not venture a formula for its correct and permanent solution, but we do feel that one suggestion should be made.

Practical industry should be largely consulted in arriving at workable plans. Industrial leaders cannot themselves press their ideas too emphatically. They are in a prejudiced position, and they know it. However sound their proposals, they are bound to be suspected of working for their own interests. No doubt they are so striving, but that does not keep them from having a clear understanding of what it takes to convert an idea into a commercial reality.

Unless legislation supervenes, the heads of experiment stations, universities, etc., have the power and the responsibility to determine their own policies. They may do so without regard to the practice of other institutions, and without regard to industry. We may presume that they will be guided by their concept of the public interest. We believe the public interest will best be served by policies which promote the most thorough development and most aggressive merchandising of the product which embodies a worthy patent. The men whose life work is to meet and solve those problems can reasonably be expected to offer the wisest of counsel as to ways and means for making the most of the publicly developed inventions.

# Cost Finding

ARTHUR O. FOX, one of the oldest living Honorary Members of the American Society of Agricultural Engineers and an octogenarian, boasts: "I still have enough of the old pioneer spirit left in my blood to keep me going head up, tail over the dashboard, and ready to kick." And he shows it in a constructive suggestion that agricultural engineers take steps to obtain, as a basic factor and guide in their work, more definite determination of farm operation and production costs.

Agricultural engineers have talked a lot, with the support of some figures, about reducing the costs of producing everything from apples to wheat. Mr. Fox would have them spend more time on farms with a pencil and a bunch of blank index cards making notes on layout, feeding methods, overhead, man time, machine time, team time, materials, and cost and selling price results for each of numerous operations. Then they would have real data on which to base continued work in machines, building materials and applications, on which to measure results in terms of effect on production costs.

As to the importance of accurate cost figures, Mr. Fox says "No business, whether on the farm or in the factory, can succeed nowadays unless the cost of production of each and every principal finished product is definitely known. . . . . There is actually no difference in the fundamental principles which govern production in the factory and production on the farm, except that one has a roof over it and the other has not. Every operation of production in the factory and every operation of production on the farm is a success or failure depending primarily upon the costs of production. . . . . The fundamental philosophy of cost finding on each farm must likewise be known before the farmer can definitely determine what, if any, profits each product will yield him. It is not at all necessary to follow in detail the prescribed methods employed for factories and similar institutions. I know from experience, both in farming and manufacturing, that when once the philosophy of cost finding is clearly understood, very simple methods of application may be employed in agricultural production."

Mr. Fox' remarks are in line with the efforts of others to analyze the field of agricultural engineering to a broad but briefly stated guiding principle, in order that agricultural engineers may push forward their own work with maximum efficiency, practicing what they preach.

# Patent Principles and Practice

By George D. Jones

THE CONSTITUTIONAL provision for the granting of patents to inventors is found in Article 1, Section 8, of the Constitution of the United States, and empowers Congress to "promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries."

Under this article, the Commissioner of Patents, after a complete investigation, and when satisfied that the applicant is the original and sole inventor of some new and useful improvement, will issue to the applicant a "patent." This patent is a grant and is issued in the name of the United States of America under the seal of the Patent Office, is signed by the Commissioner of Patents, and is good for a period of seventeen years from the date of issue.

A patent comprises four parts, (a) the government grant, (b) drawings fully illustrating at least one embodiment of the invention, (c) specification which fully describes the embodiment and explains the drawings, and (d) one or more claims, each of which define the exact limits of the invention.

The claims in a patent are the most important part of the patent. Regardless of what is shown in the drawings or described in the specification, the invention resides in the claim or claims and nothing more. The inventor, or his assignee, is bound by the claims of the patent, and under ordinary conditions the claims will not be enlarged by reference to the drawings or specification. One who fails to claim subject matter which is new and described in the subject matter of the patent, dedicates it to public use, unless the subject matter so described is claimed in other applications or patents, in which event it should be so referred to.

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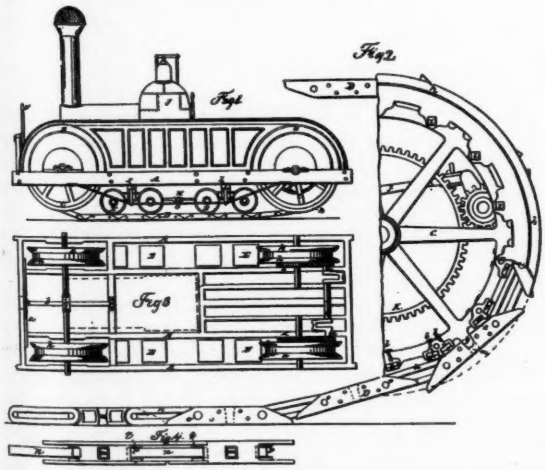
Presented before the Power and Machinery Division of the American Society of Agricultural Engineers at Chicago, December 2, 1935.

Author: Agricultural engineer and patent counsel, The Cleveland Tractor Company. Mem. ASAE.



SKETCH OF ORIGINAL AND BASIC TRACK-LAYING TYPE TRACTION WHEEL FOR TRACTORS, ACCOMPANYING PATENT No. 23853 ISSUED MAY 3, 1859, TO W. P. MILLER OF MARYSVILLE, CALIFORNIA

Generally speaking, patents may cover any new and useful invention or discovery which relates to an art, a machine, a manufacture, a composition of matter, any new and useful improvement in any one of the aforementioned subjects, and any distinct and new variety of plant which is asexually reproduced exclusive of a tuber propagated plant.

Mechanical patents cover a new and useful machine, apparatus, an article or device.

Composition patents cover chemicals, metal alloys, compounds, soaps, cosmetics, etc.

Process patents cover a new method or process of manufacturing or producing an article.

Design patents cover any new original and ornamental design such as textile designs, furniture, jewelry, chinaware, lace, etc.

The plant patent act was approved by Congress on May 23, 1930. This act provides that any person who has invented or discovered and asexually reproduced any distinct and new variety of plant other than a tuber propagated plant, not known or used by others in this country before his invention or discovery thereof, may obtain a patent therefor.

### WHAT IS PATENTABLE

An invention to be patentable must not have been known or used by others in this country, or patented or described in any printed publication in this or any foreign country, before the applicant's discovery thereof, or more than two years prior to the "filing of the patent therefor," must not have been in public use or on sale in this country for more than two years prior to the filing of the application for patent thereof; must not have been abandoned; and must not have been patented in any foreign country on an application filed by the inventor or his legal representatives or assigns more than twelve months prior to his application for patent in this country.

However, the simple fact that the invention or any part of the invention had been known or used in a foreign country, prior to the time of filing his application in the United States, will not bar the issue of a United States patent if it is shown that the inventor, at the time of making his application, believed himself to be the first inventor thereof.

Of special interest to the inventor prior to filing his application is the matter of public use or sale just referred to, that is, the invention must not have been in public use or on sale in this country more than two years prior to the filing of the application for patent therefor. This is termed as one of the statutory "bars" and, if not complied with, positively prevents the grant of a valid patent.

To the best of my knowledge, no interpretation of the statutory rule has been handed down by the courts or the Commissioner of Patents which in any way modifies or permits of evasion of its provision. The real purpose of this rule is to bar an inventor from placing his invention on the market or in use and then waiting an indeterminate time or until threatened by competition before filing an application and securing a patent, which procedure is nothing more or less than prolonging his rightful statutory grant of seventeen years. This bar covers any invention even though it is hidden in a mass of parts in a complicated

machine. Many patents of real value have been held invalid and the inventor's rights lost by ignorance or disregard of this provision.

There is one exception to this rule. If the use is purely experimental it is held as not public use, and therefore the statutory bar does not apply.

Another important matter to guard against is the secret practice of an invention. An inventor cannot conceal his invention and then, finding that his secret has been or fearing that it will be discovered, file an application and obtain a valid patent therefor.

It is up to the inventor to decide which course he intends to follow. If he wishes to protect his invention by securing letters patent thereon, he will file his application promptly and avoid trouble.

A complete application should comprise the following documents: drawing, specification, claims, oath, and power of attorney to a registered attorney empowering him to prosecute the application through the Patent Office. The power of attorney can be revoked by filing the proper documents at any time, and a substitute power filed with a petition requesting the Commissioner to grant a patent.

Two or more inventors may apply jointly for a patent. This is called a joint invention. Great care should be used by all parties when filing a joint application. I would strongly advise discussing the matter with a patent attorney before filing an application. Many patents have been held invalid by the courts when it has been shown that the invention was not joint, but the act of only one of the parties.

During the prosecution of a case through the office, the applicant has the right to amend his specification and claims, either before or after an office action, and he may amend as often as the examiner presents new references or presents new reasons for rejection.

It is important that an office action be answered in detail showing how the amendments avoid references or the examiner's objections. An amendment must be filed within six months of the date of official action. No new subject matter involving a departure from the original invention will be permitted, this should be filed in a separate application.

### INTERFERENCES

An interference is a proceeding in the Patent Office when two or more applicants claim substantially the same patentable subject matter, and is instituted to determine who is the first inventor.

An interference is similar to a judicial proceeding, and each of the parties is given full opportunity to present his case and take testimony to support his contentions. His opponents have the right to cross-examine the witnesses. The entire case is then heard before an examiner of interferences, who decides the prior inventor. However, an appeal to the Board of Appeals may be taken from his decision.

It is therefore important to any inventor that a complete record be kept setting forth the following:

1 Date of conception.

2 When first disclosed to others. It should be noted that a disclosure to others means describing so clearly that the one receiving the description thoroughly understands the invention. He should state when signing the instrument that "the invention was described to and is understood by me." Otherwise it would require considerable proof which is difficult, if and when litigation is started.

3 First drawing or sketch made.

4 First reduced to practice. A reduction to practice can be accomplished in two ways, either by actually building the invention or filing an application for a patent on the invention. Never wait and trust to memory. Record these dates at the time; delays are sometimes costly.

An inventor should remember that a grant of a patent is not a license to manufacture. In fact a large majority of owners of patents cannot manufacture their own patented device without infringing another's earlier patent. A valid patent gives the right to the owner (for a period of seventeen years) to make, use, and sell his invention to the exclusion of all others, but it does not give him the right to make, use, and sell his invention if it infringes claims of an earlier patent, even though his improvement is a decided improvement over the device illustrated in the prior patent. In order to make this point clear, let me use a concrete illustration. A patent was issued to one Warren P. Miller of Marysville, California, and dated May 3, 1859. It described and claimed the broad idea of a track-laying tractor such as is built today. It claimed in combination an "endless chain or track with the leading and driving wheels and supporting trucks, the whole constructed and operated substantially as and for the purposes set forth in said specification."

> "The nature of my invention consists in providing the machine with portable tracks of a certain formation which going around and over the leading and driving wheels hereinafter mentioned are laid down on the ground as the machine moves forward so as to form safe, solid and firm tracks for the carrying wheels or trucks which support the car, so as to enable it to run over soft or sandy roads or places with the same facility as over solid roads without sinking in the earth, and at the same time furnishing a hard, smooth and comparatively straight surface for the carrying wheels to roll on, thereby saving a large amount of power."

There have been hundreds of patents granted on track-laying tractors since this date, but every tractor of that type built having endless tracks, idlers, and drivewheels and supporting trucks infringed this Miller patent. However, after the patent is dedicated to the public, at the expiration of the seventeen-year period, anyone has the right to build the device. We in the industry have hundreds of inventors who write or call on us wanting to license the company or sell outright patents which are of no value to us due to what are called dominating patents.

While we are on the subject of industry, I would like to clear up certain erroneous beliefs regarding the industry's relation to patents. No one in the farm equipment industry, to my knowledge, deliberately steals ideas from an inventor. Each of the farm equipment concerns of which I have intimate knowledge are exceedingly diligent in new developments, and naturally try to protect each and every improvement as developed. Contrary to common belief, these concerns do not acquire patents simply to keep them off the market and place them in cold storage, in order to retard progress. I believe this thought comes from the erroneous idea just referred to relative to dominating prior patents, and, of course, if the manufacturer, after securing a patent, finds they cannot build the improvement without infringement, they must file the patent away until the prior patent is dedicated to the public.

Thousands of letters are received by the farm implement industry each year from men who have ideas that they think are patentable. It is the policy in our company, and I know it is with other manufacturers, to urge these inventors to first protect themselves and to tell them how this protection can be accomplished. There are records in my office showing where we have actually advised the inventor that we would be glad to take out the patent for him and then take a license to manufacture under the issued patent. This provides the patentee with a good patent and also

permits him to either license others or sell the patent outright.

Hundreds of patents have been purchased by the implement industry, and in many instances they have found after a short time the patented device did not serve their purpose, or it was too expensive for manufacture. When this occurs, the error is on the manufacturer and at his expense.

Now just a word in regard to some such statement as the following, so often heard: "The . . . . . Company stole my idea, and they are so big I cannot fight them." It is very common in patent law practice to find that two, three, or four persons have thought of the same idea at about the same time. One of these men is diligent and is possibly employed by some manufacturer. The others dream about it or make a very crude model, perhaps a sketch, and then proceed to forget about it. The man who is diligent applies for a patent, and if it is new and useful, it is granted. Immediately we hear the old story "They stole it from me." That is one reason why we have rules of practice for interference proceedings where any inventor has the right to prove that he is the first and original inventor.

No efficient patent department of a manufacturer will permit a product or improvement to be made on that product until their attorney has made a study of the prior art. It is the function of the patent attorney to guide the engineering department away from infringement and avoid litigation.

### PATENT PRACTICES OF PUBLIC INSTITUTIONS

The increasing interest by American institutions and colleges on research activities carried on by the faculty and staff members is very apparent today. In fact, I understand one of our larger universities sets aside each year $100,000.00 to support new projects carried on by faculty members and graduate students.

A great deal of the research carried on by our educational institutions must of necessity be concerned with the extension of work that is not utilitarian. However, there is a large amount of research work going on that frequently results in discoveries or inventions of great value. Some of the inventions must be protected against misuse by the general public, while other inventions are of great commercial interest. Each institution in which these inventions are produced is necessarily faced with a rather grave problem, namely, is it advisable to dedicate the discovery to the public, or should the invention be patented, licenses issued thereon, and the returns therefrom be placed in the treasury of the university? Legally, of course, the invention rightfully belongs to the inventor. However, either due to a contract or understanding, or due to the inventor's interest in the institution, the patents are generally assigned to the university, or an association, or to a corporation. Numerous universities have adopted policies in the handling of discoveries which originate with the faculty and graduate worker. The fact still remains, however, that all of the institutions of learning are facing a grave problem as to how to develop these patented inventions for the greatest social benefit. This question is certainly becoming one that is harder to answer each day.

The Carnegie Institute of Washington has adopted a policy governing the subject of patentable devices which originate through research workers paid by the Institute. In May, 1923, the following resolution was adopted: "It is the intention of the Carnegie Institute of Washington that any new and useful inventions or discoveries that may result from research financed by the institution, shall be dedicated to public use and that for this purpose all patents thereon shall be taken out by, or for, or assigned to, the institution." The Carnegie Institute has carefully made out a program which involves a carefully controlled production under licenses after the patent, and the assignment, has become effective.

It appears that the general practice of the institution is to make such license agreements with reliable institutions without any idea of profiting financially from such licensing agreements. The institution reserves the right to choose an individual, firm, or corporation which may be licensed, and governs the sale of such inventions, thereby insuring the carrying out of the institution's policy.

Columbia University in 1924 amended the statutes of the university to provide for an administrative board of university patents which comprises the president and the treasurer of the university, and not to exceed seven other persons to be appointed by the trustees. Each holds their office for a term of three years. The administrative board of university patents has vested in it authority, subject to the direction and control of the trustees, "to accept for, and on behalf of the university, by assignment, or otherwise, either directly or through trustees, or holding corporations, patents, patent applications, royalties, licenses, or rights therein, covering inventions, or processes, whether produced by members of the teaching staff of the university, or by the use of the university laboratories or otherwise." This board has the right to arrange, on such terms as it deems proper, for "the use, manufacture, sale, or other disposition thereof, or all rights therein, with power, subject always to the approval of the trustees, to arrange for the use or division of the proceeds thereof."

Pennsylvania State College has adopted a policy governing the administration of patents and copyrights from research at that institution. This policy covers inventions financed two different ways, as follows:

1 In the case of research and development which is wholly financed by the institution, the institution may require that the patent be assigned to it. However, in the event that the college disposes of the patent of a member of the staff at a price in excess of the cost of the patent, the board of trustees may determine a just compensation to be paid the inventor. There is a rule that if the college fails to pay the cost of obtaining a patent within one year after the discovery has been announced to the college, all right, title and interest in the patent shall remain in the name of the inventor and he may apply for and receive patent protection for his invention.

2 Where research is wholly paid by an outside organization and such an agreement is entered into by the college and the organization, the patent rights then belong to the organization financing the work. Where the research is carried on by staff members and is performed on their own time, and at their expense, then the patent is the property of the staff member.

The entire matter of public institutions carrying on development work and protecting the inventions by patents is of grave importance to commercial industries, and undoubtedly some equitable program could be arranged by the ASAE for patents in this field that would be of mutual advantage to the institution, industry, and the ultimate consumer.

I have attempted to give a very cursory view of patent procedure. I have purposely avoided the intricate and somewhat complicated details relative to patents. In conclusion let me again emphasize the great importance of records properly describing the invention. Learn to date every sketch, description, and note. Above all, when explaining the invention to others for record purposes, see that they thoroughly understand the invention and so state when witnessing the sketch, description or drawing.

# A Steel Frame House

By L. S. Hamaker

THIS PAPER will deal briefly with the development of a steel frame for residences produced by our company. Four of these houses have been built in Washington. Fundamentally they are steel skeletons which can be used in connection with any of the traditional building materials.

The steel skeleton is made up of rectangular strip-steel framing units three feet wide and of ceiling height. Steel window or door frames are welded into this rectangular unit so that the blank wall, window, or door units are interchangeable. In addition to the units themselves, there are standard length steel joists.

The construction of the steel skeleton is simple. A template is cemented to the foundation, the first floor joists are securely bolted to this template, and the first floor units to the joists. The construction of the second floor and the roof is merely a repetition of this process.

So rapidly can these steel units be erected into a completed skeleton that in Washington five men did the entire job in less than fifteen working hours. Not only was the skeleton erected in this time, but the steel stairways were installed, the heating and air-conditioning unit put into place, and a portion of the prefabricated plumbing unit bolted into the kitchen wall of the house. At that point the home was turned over to the Washington contractor who was building it. With carpenters, bricklayers, and laborers, he completed the job.

The outside of the house consists of inch-thick sheets of cork fastened securely to the steel frame. This, in turn, is covered with a heavy building paper, and finally the exterior surface of common brick was laid up in the regular way. The inside walls and ceilings are of heavy gypsum board which is secured by means of simple clips to the steel frames. In Washington, oak was used for floors. This, however, is not mandatory, as any common floor material can be utilized.

The net result in this instance is a seven-room brick house with a steel frame which is fireproof, vermin proof, and will withstand wind, lightning, and storm. The owner of such a home certainly has less fear of being aroused in the middle of the night by a fire of any serious proportions.

One of the features of the house is the prefabricated plumbing unit which is incorporated into the walls and which serves both the bathroom and the kitchen. So efficient is this unit that in Washington, although the steel frame for the first house was not started until noon, all the water used on the job from the next morning on was run through the plumbing system of the house itself.

This highly fire-resistant, modern home was completed ready for occupancy in about three weeks working time by a normal number of building mechanics.

At this time there is one basic floor plan for these houses with three simple variations. This floor plan consists of a modern kitchen, a large dining room, living room and porch on the first floor; three bedrooms, a bath and storage room on the second floor, all of which have plenty of closet and storage space, and a detached single-car garage.

In cost it does not exceed, and may possibly be less than, a house of similar size constructed of wood frame.

While the development has not progressed far enough as yet to be positive, it is felt that the simplicity of this type of construction will make it possible to ship the necessary steel for a house to the buyer who can, with local labor, erect it. If this development should be practical, a house of this sort will add greatly to the safety and permanency of frame dwellings. Not only will the farmer have a home which is well built, properly designed and free of hazards, but his wife will have a home in which she can do her housework more easily and in fewer hours. There is no waste space in the house, no walls need be repapered. The kitchen is efficient and is designed to cut down to a minimum the time and steps needed for the preparation of meals and the clearing up after them. It is within reason that a house of this type may furnish the solution of some of the more pressing problems having to do with rural as well as urban housing.

It should be recognized that the problem of good, though inexpensive housing is not a simple one. Perhaps 80 per cent of the families in America had an annual income in 1929 of something in the neighborhood of $1250. Some housing economists insist that not more than two years' income should be expended for a house and lot. This would place the ideal costs somewhere between $2500 and $3000. At once the idea of the prefabricated house suggests itself, on the principle that factory fabrication in large units to be quickly and cheaply erected on the site will greatly reduce costs.

Doubtless this could be worked out satisfactorily but there is another problem. We have hundreds of thousands of well-trained and experienced building craftsmen—masons, carpenters, lathers, plasterers, electricians, plumbers, etc. These men must have work. Quite naturally, they will resist to the utmost any trends which they think will lessen their opportunities for employment.

It was with this condition well in mind that our company did not undertake the production of a more completely prefabricated house, but confined its development work to a steel frame in easily handled and quickly erected units to which on both the interior and exterior any of the customarily used building materials could be attached, thus affording work for the various craftsmen under whatever local labor conditions may prevail. This labor problem is not so acute in rural districts. Already we have the prefabricated barn, silo, machine shed, chicken house, brooder, grain bin and corn crib.

Paper presented before the Farm Structures Division at the 29th annual meeting of the American Society of Agricultural Engineers, at Athens, Georgia, June 17 to 20, 1935.

Author: Vice-president and general manager, Berger Manufacturing Company.

## Chemurgic Progress Outlook

A WIDE variety of miscellaneous new products using farm grown crops as raw materials will be described at the Second Dearborn Conference on Agriculture, Industry and Science. The Farm Chemurgic Council hopefully predicts that within ten years, provided proper research, both fundamental and applied, is undertaken, American industry can absorb the output of 50 million acres.

# Farm Dwelling Construction

## By Fred B. White

THE NEED of fire-resisting materials in farm dwellings and buildings made it almost inevitable that a simplified type of construction would be developed in the low-cost field. Quite a bit of study has been directed along the lines of a completely prefabricated steel house. As much as could be said for the remarkable progress that has been made in these efforts, this type of dwelling, of course, is still somewhat beyond the means of the average southern farm builder.

Our company, in an effort to demonstrate the practicability of the application of sheet steel in farm buildings, recently designed and erected a model farm homestead, consisting of a four-room dwelling and several auxiliary farm buildings. However, since previous developments had already established the practicability of using sheet steel for farm buildings, such as barns, stables, etc., this farm homestead was developed primarily to establish an actual test of the application of sheet steel in farm dwellings and to provide an example of an adequate farm dwelling which might be helpful in promoting better housing in agricultural sections.

With a view to reducing the cost of fire-resisting steel structures and at the same time retaining as many as possible of the advantages steel offers in farm buildings, our recent studies, including the model homestead just mentioned, have been directed mostly to using wood framing with sheet steel for roof, outside and inside walls, and ceiling. This has been termed "steel-clad" construction.

Standard stock steel sheets are utilized in steel-clad dwelling construction, and no expensive materials, special tools, or highly skilled labor are necessary. Our studies have also been a test of whether or not the average man living in a rather remote community could erect a dwelling of this kind without bringing to his assistance additional skill.

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Presented at a meeting of the Southern Section of the American Society of Agricultural Engineers at Jackson, Mississippi. February 1936.

Author: Engineer, sales promotion division, Tennessee Coal, Iron and Railroad Company. Assoc. Mem. ASAE.

A brief description of the "steel-clad" dwelling which was recently built near Birmingham, Alabama, will illustrate the simplicity of this type of construction.

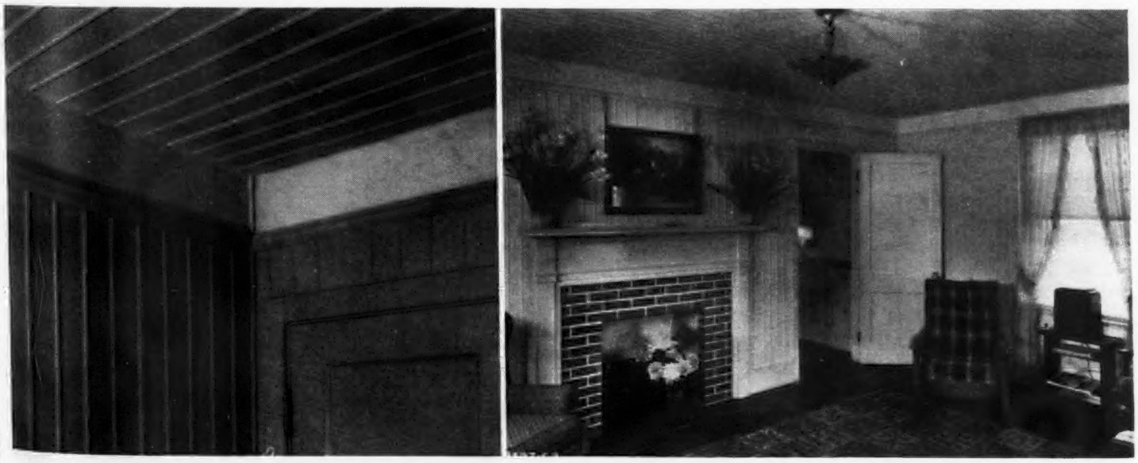
*Foundation.* The masonry foundation, chimneys and piers, including curtain wall with ample ventilators, are of the usual size and thickness used in standard wood construction.

*Framing.* Floors and most of the framing of the steel-clad dwelling are identical with that of an all-wood frame house of the same grade of construction. As steel sheets are usually applied horizontally outside for siding and vertically for inside walls, there are in addition to the conventional vertical studs of all-wood construction, horizontal 2x4 headers placed between the studs, so spaced that the steel sheets may be nailed in either direction. These headers, incidentally, add materially to the strength and rigidity of the building.

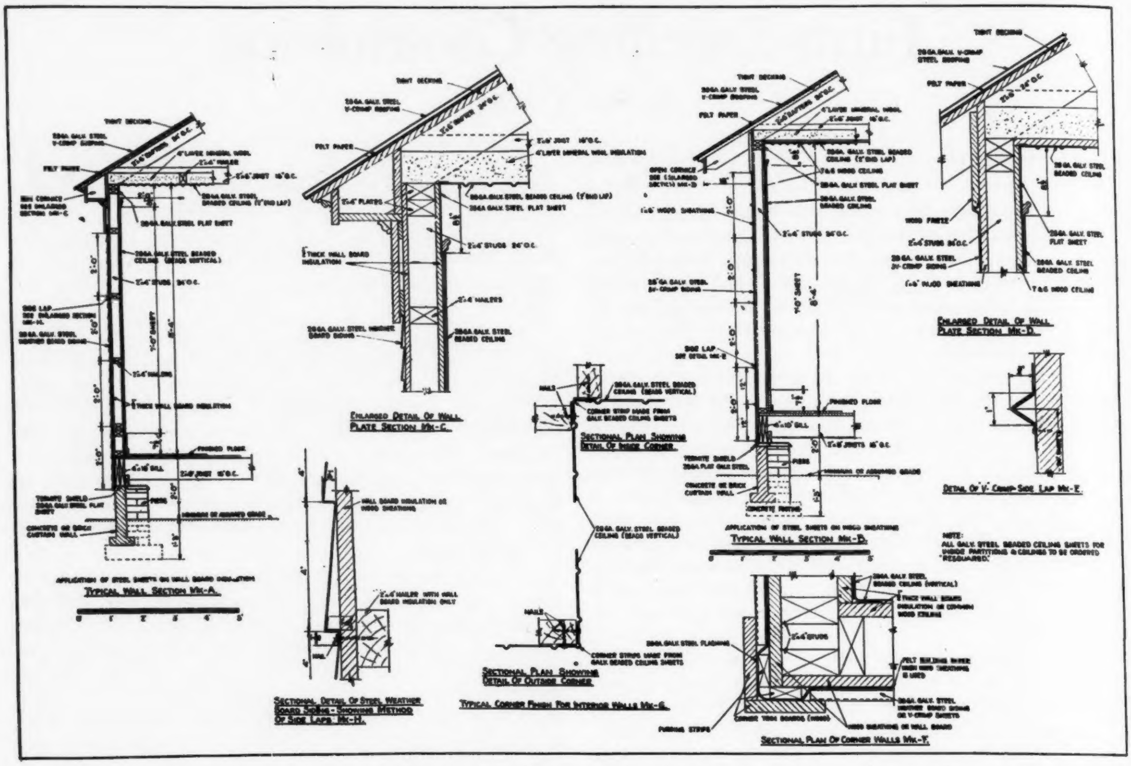
*Wall Construction.* A medium grade of one-half-inch wall board insulation was applied on the exterior walls between the studding and the galvanized steel weatherboard siding, as well as on the interior walls between the studding and the beaded steel ceiling sheets. This type of construction provides a tight dead air space for further heat insulation, in addition to the insulating value of the wallboard, and further acts to minimize sound transmission through the walls.

Common one-inch sheathing may be applied on the exterior of the studs as a substitute for the wallboard and a good grade of felt building paper used between the sheathing and steel sheets with very satisfactory results. This method would eliminate the necessity of horizontal headers between the studs.

*Siding.* Twenty-eight-gauge, galvanized copper-bearing steel weatherboard siding sheets in effective formed widths of 24 inches, simulating six 4-inch weatherboards, were used for siding. It is necessary to lap the sheets two or three inches at ends. Special crimps are provided on edges of sheets for watertight side lap. Flat-head, galvanized eight-penny siding nails were driven from four to six inches



INTERIOR VIEWS OF STEEL-CLAD FARM DWELLING. (LEFT) CLOSE-UP SHOWING FINISH OF WALLS AND CEILING. (RIGHT) PART OF THE LIVING ROOM SHOWING DECORATIVE EFFECTS POSSIBLE WITH STEEL WALLS



TYPICAL WALL SECTIONS AND METHODS OF SHEET-STEEL APPLICATION DESCRIBED. NOTE DETAIL ON LEFT SHOWING STEEL WEATHERBOARD SIDING AND WALLBOARD INSULATION

apart along horizontal laps, and immediately under the projecting crimp at vertical laps, one nail was driven at the uppermost edge of each face or "board." A few nails were driven throughout the body of the sheet, likewise, directly under projecting crimps, to hold the sheet firmly.

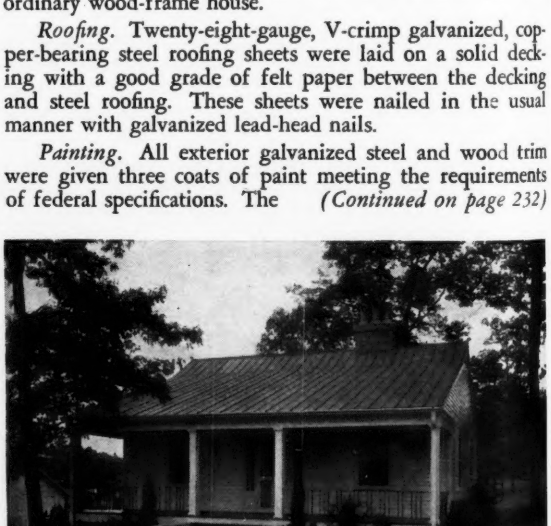
As a variation in the appearance of the siding, galvanized V-crimp steel roofing sheets may be applied either horizontally or vertically. Applied horizontally, this type of sheet would simulate the wide-board construction which is often applied on bungalows.

*Interior.* Twenty-eight-gauge "dul-kote" beaded steel ceiling sheets, which have a galvanized, velvety surface especially prepared for painting, were applied vertically up to the picture molding for the interior wall finish. These sheets have round beads of 1/8-inch radius, spaced three inches on center, extending lengthwise of the sheet. A 10-inch border of plain sheet steel was applied above the picture molding to the ceiling to improve the appearance by contrast with the beaded steel. These sheets were lapped one to two inches at ends and over one bead or crimp at sides. They were carefully nailed with 1½-inch plasterboard nails spaced about five inches apart. The same beaded ceiling sheets were used for ceiling finish. Nailing strips of 2x4 material were placed between the ceiling joists located at the side laps of the ceiling sheets. The outside and inside corners of the room walls were finished with corner strips made from a strip cut from a beaded ceiling sheet about one inch on each side of the bead; these 1-inch flanges were turned behind the wall sheets and nailed.

*Ceiling Insulation.* It is estimated that approximately 50 to 75 per cent of the major heat losses from residential buildings occur through the ceiling. Consequently, a 4-inch layer of mineral rock-wool insulation was placed above the ceiling sheets between the ceiling joists. Actual tests have proved that this steel-clad dwelling is considerably cooler inside than outside shade temperature in summer, and that in winter less fuel is required to heat it than the ordinary wood-frame house.

*Roofing.* Twenty-eight-gauge, V-crimp galvanized, copper-bearing steel roofing sheets were laid on a solid decking with a good grade of felt paper between the decking and steel roofing. These sheets were nailed in the usual manner with galvanized lead-head nails.

*Painting.* All exterior galvanized steel and wood trim were given three coats of paint meeting the requirements of federal specifications. The *(Continued on page 232)*



EXTERIOR OF FOUR-ROOM, STEEL-CLAD FARM DWELLING

# Harvesting Native Grass Seed

By Guy C. Fuller

THE PHASE of Soil Conservation Service work of particular interest to agricultural engineers has to do with the means by which the seed necessary to reestablish native sod is to be harvested. Grass nurseries have been established to collect native grass seed for the purpose of reseeding large areas of abandoned land in the dust-blown regions; to encourage reseeding and improvement of those areas that are approaching the abandonment point because of damage done by overgrazing and successive years of drought; to increase and encourage the use of valuable species never before used; and to determine the best cultural methods and to encourage proper management of established vegetation.

Soil conservation work is being carried on over the entire United States, but the problem to be dealt with here is confined to the territory west of the 98th meridian. This line marks a general division in vegetation, especially in the grasses. In general, grasses are divided into two groups —tall grasses and short grasses; the tall grasses appear east, the short grasses west of this line.

In general, the harvesting of some of our short grasses presents a difficult problem. Many species occur in waste places, along railroad banks, roadsides, fence corners, and rugged hill-tops, making the use of harvesting machinery impossible. Seed collecting in such places is done by hand. The tops are cut with hand sickles or large knives and put into bags thrown over the shoulder. These tops are dried and later threshed and cleaned for planting.

Seed gathering in such places has been greatly facilitated by a hand-pushed stripper devised by Gerald Mott. It embodies a two-cycle washing machine engine which operates a 40x14-inch cylinder at 700 revolutions per minute. The hopper is made of sheet metal mounted on an eccentric frame supported by two automobile wheels on pneumatic tires. The eccentric frame allows for height adjustment. The use of such a machine is limited but it serves the purpose for which it was designed.

One of the most economically valuable short grasses is blue grama (*Bouteloua gracilis*) which is widely adapted to the great plains area and is recognized as one of the most valuable species for erosion control. To mow, rake, and thresh the crop would not be feasible because too much seed would be lost in handling, therefore grass strippers were used for harvesting and worked satisfactorily where large machines could be operated.

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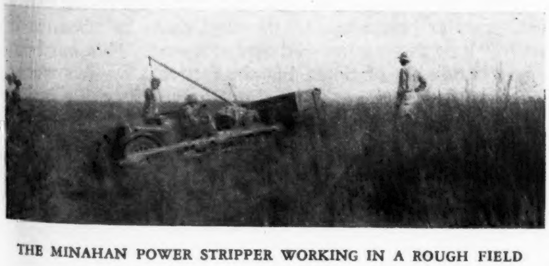
Presented before the Power and Machinery Division and the Soil and Water Conservation Division of the American Society of Agricultural Engineers at Chicago, December 4, 1935.

Author: Assistant agronomist, Soil Conservation Service, U. S. Department of Agriculture.



THE MINAHAN POWER STRIPPER WORKING IN A ROUGH FIELD

A horse-drawn stripper will cover from 6 to 7 acres a day requiring one man and team to operate. The cylinder is a hollow drum made of wooden slats filled with staggered rows of spikes. The cylinder is operated at about 700 revolutions per minute. Height adjustment ranges from 6 to 24 inches.

To speed up the work with these machines, the long tongue used with a team was replaced with a short one and three machines were hooked in tandem and pulled with a tractor. This hook-up will cover from 25 to 30 acres a day, one additional man being required to help service the machines. This arrangement not only cuts the cost of operation but increases the acreage covered per day. The importance of this is emphasized by the fact that, under certain conditions, ripe seed may all be shattered within a few days. Use of these machines is limited by their small height adjustment. The ideal stripper for harvesting native grasses must be economical, able to cover from 25 to 40 acres per day, be adjustable to strip grasses ranging from 6 inches to 4 feet in height, and be simple to operate.

A power stripper, the first machine of its kind, has been built by a Mr. Minahan of Oshkosh, Nebr., and although not perfect, it approaches the ideal stripper.

An old automobile chassis serves as the power unit. The rear axle is thrown over, producing a pull instead of a push effect. The steering gear is attached to the frame over the rear axle, the steering rod being lengthened. A cylinder is mounted in one side of the large hopper, similar to the horse-drawn stripper. A bar ten feet long with eighteen inches on each end turned at right angles fastened near the end of the frame forms a support for the hopper. A steel cable with adjustable clamps extends downward and fastens to the back side of the hopper. A long lever attached in the center produces a lift or height adjustment by the eccentric action.

The cylinder is driven from what is now the front wheel by chain and sprockets.

Advantages in favor of the power stripper are as follows:

1 It moves under its own power.
2 It may be transported from one field to another without any adjustment.
3 The height adjustment ranges from 6 inches to 4 feet.
4 It is possible to secure cleaner seed because of the flexibility of the cylinder and hopper. By pulling down on the rope the hopper is raised allowing it to pass over noxious weeds or any other undesirable materials.
5 This adjustment allows the machine to be operated upon rough ground. Much of our native seed is harvested in fields where machinery has never been used before.
6 It can be operated by one man.

These strippers and our ordinary farm machinery have solved the harvesting problems of most grasses quite satisfactorily, but leaves another harvesting problem of greater magnitude.

The story of how thousands of acres of valuable native grass sod were turned under with the plow to grow \$2.00-wheat, and later abandoned, is a part of our agricultural

history. Recent years of drought and dust storms have thoroughly impressed upon the great plains farmers the importance of reestablishing an economic and protective covering upon this vast acreage that has been subjected to the ravages of wind erosion.

At a meeting in Colorado Springs in May 1935, each project leader was requested to submit a list showing the amount of each native grass he could use on his project. When the totals were made, the buffalo grass (*Buchloe-dactyloides*) seed requests amounted to 105 tons. That figure is quite significant. Why was the request so great for this grass seed? It was undoubtedly based upon the following facts:

Buffalo grass has proven to be drought resistant and has demonstrated its ability to stage a remarkable comeback as soon as favorable conditions prevail for even a short period of time. The grass is palatable and highly nutritious at all stages of growth. It is widely adapted to soils and climatic conditions, and may be propagated by seed or vegetatively. Stolons or runners reach out from the established plant and take root at the nodes, where another plant develops. This tends to increase the percentage of ground cover, to supply more grazing, to smother weeds and to protect the ground surface, all of which makes for better pasture and soil protection. The problem of establishing this grass vegetatively has been considered and some of it has been done, but that method is expensive and sod is not available.

In buffalo grass pastures both male and female plants are found, the female bearing the seed. These plants are not evenly distributed over the fields but occur in patches varying in size. In an area where female plants predominate, a concentration of seed is found while in an adjoining area predominantly of male plants, little, if any, seed may be found. This makes it difficult to even estimate the yield per acre.

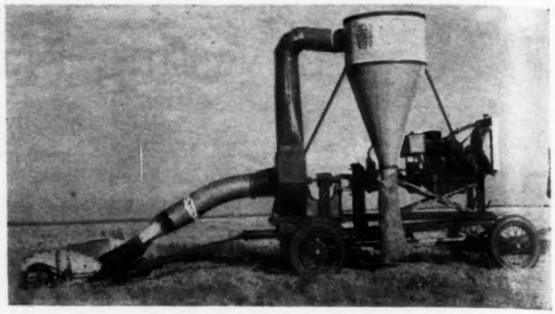
Seed is produced throughout the growing season from early summer until frost. No definite harvest period may be set, but the logical time to collect seed is in the fall because more seed is available.

The seed, or caryopsis, is found in a small burr which is produced on the stems of the plants down among the curly grass blades. The burr is composed of a tough fibrous material made up of one or more parts, usually two or three. Each part may or may not contain a caryopsis. On one end of the burr are found small pointed and spreading projections which cause the burr to cling to the grass blades. As these small burrs mature and dry, they fall to the ground or drop at the slightest jar. With these facts in mind we faced the problem of how to harvest the seed.

The job is not simple, as in designing a machine nothing may be incorporated that would in any way damage the pasture. The idea of a vacuum machine was tried out at Chillicothe, Texas by Mr. Roy Quinby in the fall of 1934. Mr. Quinby did not have sufficent time to give the machine a satisfactory test, and so far as I know, nothing has since been done on it. As a satisfactory machine was not on the market, the Soil Conservation Service decided to have a machine developed.

The problem was presented to Frank. J. Zink, associate professor of agricultural engineering, Kansas State College, and L. C. Aicher, superintendent of the Fort Hays Experiment Station at Hays, Kansas. Mr. Zink had developed a machine which we believed could easily be adapted to the harvesting of this seed, and Mr. Aicher had been thinking along the lines of our need.

Recalling the seeding habits and plant characters of buffalo grass, it could not be determined in advance just



THE MACHINE CONSTRUCTED AT HAYS, KANSAS, INDICATING A CHANGE IN NOZZLE DESIGN. THIS ARRANGEMENT, WITH THE BRUSH BACK OF THE NOZZLE, WAS FOUND INEFFICIENT

how difficult it would be to gather the seed. No accurate data was taken from the first few trials; changes and alterations made were based upon general observations. It was not until the machine approached a reasonable degree of efficiency that any accurate data were taken[1].

### THE HAYS MACHINE

This machine was mounted upon a four-wheel trailer with pneumatic tires; powered by a four-cylinder motor of 20 horsepower, and equipped with automobile transmission for operation of the fan. A 10x30-inch fan with 12-inch intake was geared to run at 2,200 revolutions per minute. A brush, 7 feet long and 18 inches in diameter, with 8-inch maple core, 3-inch opening for shaft, and 5-inch flexible fibers was built into the vacuum nozzle. Brush rotation was clockwise, driven from the trailer axle. It was first timed to make about 150 revolutions per minute. Considerable foreign material but a very small per cent of the seed present was picked up with this arrangement. With the brush speed increased to 350 revolutions per minute and a nozzle area of 504 square inches, volume and velocity of air were not great enough to clear the nozzle of heavy foreign material.

With the brush removed and a 6-inch rubber belt attached to the back side of the nozzle, the rubber belting followed the slight depressions on the ground surface tending to maintain a better vacuum. Counts were made in small rectangular areas and showed approximately 40 per cent of the seed taken up. The belt was removed, allowing more air to pass under the back edge of the nozzle. This increased the efficiency of the machine about 8 per cent. The machine was not approaching expectations so the number of square inches in the nozzle was cut from 540 to 288 at the point of contact on the ground. This was done by fitting two pieces of wood inside the nozzle 18 inches from each end and sloping them toward the intake pipe. Counts made as before indicated that this machine gathered about 60 per cent of the seed. At this point, there was very little difference from the efficiency of the Manhattan machine developed by Mr. Zink.

From the tests conducted thus far, many things had been observed but the general consensus of opinion is that a much greater percentage of the seed could be obtained if the top growth were mowed and removed. This has been argued a number of times, but the fact that farmers would not allow their pastures to be clipped an inch or two inches from the ground eliminated the practice. However, a lawn mower with a grass catcher was taken to the pasture and

[1]Mr. Zink's story of the development of his harvester appears elsewhere in this issue, the author's description of that machine and its development is therefore omitted in the printing of this paper.

small areas clipped. Tests were run with both machines and counts made as before to determine the efficiency of the machines.

## CONCLUSIONS

1 Ordinary farm machinery may be used for harvesting seed of most native grasses.

2 The new power stripper has many advantages over the horse-drawn machine, principally because of its flexibility and amount of ground covered.

3 Buffalo grass seed may be secured with a vacuum machine.

4 Machines of this design will harvest from 50 to 60 per cent of the seed under average conditions and will not damage the pastures.

5 For best results, pastures moderately to heavily grazed must be selected from which to harvest seed. A chain drag used on pastures of this nature will slightly increase the amount of seed obtained.

6 Mowing pastures will not be feasible because of added expense and lack of available pastures where mowing would be permitted even at rental prices.

7 The efficiency of the machine will be determined by the density of turf and how securely the seeds are imbedded in the soil.

8 Because of the demands for buffalo grass seed, the amount of money and time involved in perfecting these machines to a point of more than 50 per cent efficient has been entirely worth while.

TABLE 1. SUMMARY OF TESTS

| Machine | Nozzle area sq. in. | Treatment | No. of areas | Total seed | Seed left | Per cent efficient |
|---|---|---|---|---|---|---|
| Hays | 540 | Belt on nozzle* | 4** | 152 | 91 | 40 |
| Hays | 540 | Belt removed | 4 | 142 | 74 | 48 |
| Hays | 288 | Grass clipped 1 inch | 5 | 249 | 13 | 95 |
| Hays | 288 | Clipped 1 inch | 5 | 103 | 28 | 72 |
| Manhattan | 288 | Clipped 1 inch | 4 | 104 | 33 | 68 |
| Manhattan | 288 | Clipped 1 inch | 5 | 92 | 28 | 66 |
| Manhattan | 288 | Not clipped | 7 | 240 | 103 | 57 |

*6-inch rubber belt attached to rear edge of the nozzle.

**Number of areas in which counts were made before each test. An average of 34 counts indicates an overall efficiency of 63.7 per cent.

# Design of a Machine for Harvesting Buffalo Grass Seed

By Frank. J. Zink

IN THE central great plains region buffalo grass is one of the most important of the native grasses. It is highly valued as a pasture crop for several reasons. It is nutritious in all stages of growth, palatable, adaptable to widely different soil and climatic conditions, and most important of all it is especially drought resisting. Existing areas of this grass are practically all original sod. Only a few small areas have been reestablished subsequently to a period of cultivation. Such areas have been reestablished by natural means of propagation or by spreading chopped sod. In a few instances small blocks of sod 4 to 6 inches square have been set in the soil 3 to 4 feet apart. No case has come to my attention where any but small experimental areas have been reestablished by seeding.

In no instance is it known that the seed of this grass has been harvested except by laborious hand methods. Hence only small amounts have been gathered which usually have been used in experimental grassland nurseries.

Attention was focused on the need of quantities of this seed when soil conservation leaders met at Colorado Springs, May 27 and 28, 1935. A summation of the needs of each indicated that a total of 105 tons of seed of buffalo grass was desired to combat wind and water erosion in the central great plains areas. This need was indicated in spite of the fact that there were no methods or machines available for harvesting the seed. A great many individual farmers have indicated that if they could do so it would be their desire to reseed some of their land to buffalo grass for pasture purposes. The extent of this need is not definitely known.

The seeding habits of the plant do not lend themselves to an easy solution of the harvesting problem by machine methods. The seed is produced within about one-half to one inch of the ground. It matures throughout the growing season, hence the ripening time varies extremely, and to the extent that the harvesting time may extend over a period of several months. As the seed matures and dries, it falls to the ground or is held unattached by the stem in the dense turf. The turf is extremely dense and usually very short, normally under 3 inches in height. The seed itself somewhat resembles a sand burr, except that the spines are soft and form a cluster at one end of the seed.

These characteristics indicate that the ordinary harvesting machines are impractical. The author was asked to cooperate with A. E. Aldous, director of the Kansas area, and the agronomists of the Soil Conservation Service of the USDA on this problem of harvesting the seed. From previous experience in the experimental control of the pea aphid or the alfalfa green bug by means of a vacuum machine, it appeared that such a device might be suitable for harvesting. By this means the seed could be sucked into the machine and collected along with considerable other debris. This introduced the subsequent problem of cleaning the seed. However, machines were available for handling this work.

A suction machine which had already been developed therefore was tried on some experimental areas. In design the machine resembled an oversize vacuum cleaner. Power was furnished by tractor power take-off for the pea aphid work and in the earlier trials for harvesting of buffalo grass

Author: Formerly associate professor of agricultural engineering, Kansas State College. Mem. ASAE.

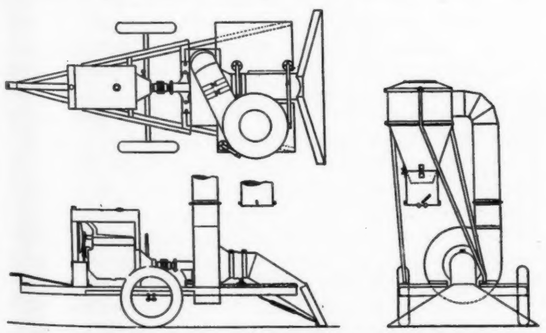
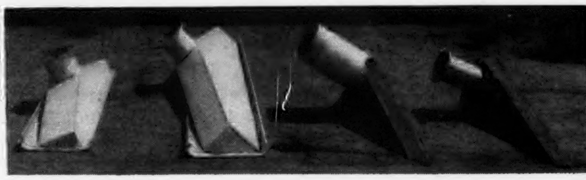


FIG. 1 PLAN, SIDE AND END VIEWS OF THE BUFFALO GRASS SEED HARVESTER WITH INDEPENDENT POWER UNIT AS DEVELOPED BY MR. ZINK BY MODIFICATION AND ADAPTATION OF AN EXPERIMENTAL VACUUM PEA APHID CATCHER. SPECIFICATIONS ARE GIVEN



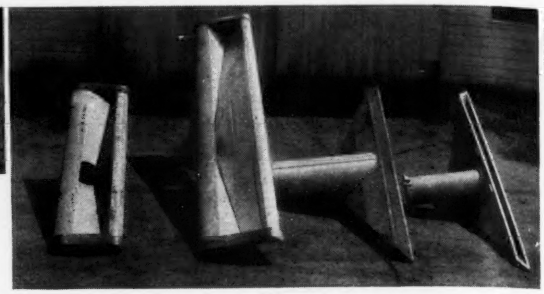


FIG. 2 (ABOVE) SIDE VIEW OF EXPERIMENTAL NOZZLES FOR BUFFALO GRASS SEED HARVESTER. FIG. 3 (RIGHT) BOTTOM VIEW OF EXPERIMENTAL NOZZLES FOR VACUUM PICK-UP OF BUFFALO GRASS SEED. THE TWO ON THE LEFT WERE OF WOOD AND SHEET METAL WITH ELABORATE LIPS WHICH DID NOT PROVE EFFECTIVE. THOSE ON THE RIGHT ARE OF WOOD

seed. For a fan application of this sort the tractor power take-off had some disadvantages. Also from the outset it was recognized that a self-contained unit was more desired from the Soil Conservation Service organization standpoint where it was thought necessary to harvest fields at widely separated points. Light motor trucks were available for towing the harvesters, and some expense could be avoided if these trucks could be utilized in the work. Therefore, after preliminary trials a self-contained unit with its own power plant was designed which it was felt would be suitable for the job. Seed and other material were collected with an ordinary feed-grinder dust collector and bagger.

The final design as worked out from the experimental work is shown by Fig. 1. One machine was built on this design and others are under consideration. It may readily be seen that this apparatus is mainly an assembly of parts, the most of which are individually available from various sources. Specifications as worked out for this machine are:

*Type.* Motor-driven suction fan with seed collector and bagger.

*Motor.* Ford Model A, 40 hp, 2000 revolutions per minute, complete with gas tank, radiator, and storage battery.

*Clutch.* Twin-disc, for Model A Ford motor.

*Drive.* Direct connected with Morse 1.5-inch flexible coupling.

*Fan.* Inside diameter 36 inches, width 12 inches, 6 fan blades of 10-gauge steel flanged 1 inch radially mounted on cast iron hub, 1⅝-inch shaft, 2 No. 1208 New Departure bearings, housing—16-gauge welded steel, balanced rotor.

*Chassis.* Frame assembly A-shaped, of 4-inch standard channel with suitable angle and channel cross members. Axle 1.5-inch square steel for 56-inch wheel tread; 2 wheels with drop center rims, Timken bearing hubs, 2 tires—5.25x18-inch, pneumatic. Drawbar height, 23.5 inches.

*Collector.* Fan outlet 12 inches in diameter of 20-gauge steel bolted to fan housing. Rubber gasketed joint to collector, collector 58 inches in overall height; 20-gauge steel sacking attachment for 2 bags; three 1¼-inch pipe supports with floor flanges for collector.

*Suction Nozzle.* Pipe inlet to fan housing 18 inches at fan, reducing to 12-inch 18-gauge steel pipe, rubber gasketed with slip joint to cone section; nozzle 6 feet wide with 3-inch opening 18-gauge steel, forward edge of 1-inch standard pipe, pull chains with spring attachment to nozzle.

The design of such a machine is necessarily rather empirical. Suction machines are manufactured and used extensively for street cleaning, and the household vacuum cleaner is a well-known device, yet no specific data from published material were found which might be applicable to such a design.

The design of the nozzle was perhaps the greatest problem. For the pea aphid machine only one nozzle had been built and from the tests of that machine the style was one of fortunate judgment. This nozzle, however, was not successful in picking up and drawing the seed out of the grass. Therefore others were designed and used in the experimental work. These nozzles appear in Figs. 2 and 3. These figures show the relative size of the openings and the manner in which they were constructed. It was found that the narrow opening, approximately 3 inches from front to back produced the greatest velocity of air and very probably the greatest pulling power for collecting the seed. The rather elaborate front and rear lips were found to be a disadvantage from the standpoint of gathering efficiency. They were also considerably more difficult to construct than the more simplified box-like unit. One nozzle 2 inches wide was also constructed but was discarded in favor of the 3-inch size.

Results in harvesting efficiency were determined by counting the seed on a small area, then sweeping the area and counting the seed remaining. These results were not carried out to more than a preliminary conclusion but only sufficiently to assure that the apparatus was reasonably satisfactory considering the magnitude of the problem. A few of the results were as follows: In 5 quadrats having a total of 92 seeds, efficiency 66 per cent; in 7 quadrats with 240 seeds, efficiency 57 per cent; and in 4 quadrats with 104 seeds, efficiency 68 per cent. In these tests only medium-length turf was attempted because in any case of harvesting these seeds it appears necessary to carefully select the area to be worked or to give some special treatment to the turf.

This special treatment might include clipping and raking aside the dense top turf so as to expose the seed on the surface of the ground and permit the suction to be more effective. In the test work some of the areas were clipped with a lawnmower set to cut one inch. The clipping improved the efficiency of the machine from 10 to 40 per cent. It is considered that by use of a lespedeza cutting bar and a side rake this work could be done economically.

While only experimental results are available, there appears to be no reason to doubt the applicability of this machine for extended use. In a normal season it should be possible to extend the harvesting over a period of several months, weather permitting, perhaps even throughout some of the winter months. This especially should be true in the southern half of the region.

It is considered that, even though the interests of the Soil Conservation Service should wane, the demand by private parties for seed would be sufficient to warrant considerable harvesting being done. There is at present no commercial market largely because there is no supply. The seed would undoubtedly command a high price on a commercial market. The price might extend to a few dollars per pound and the seed still find a market.

As yet more information is needed on the most successful methods of propagation, the rate of seeding and the possible yield of seed per acre. It is considered that in a season of optimum conditions 100 pounds of seed per acre might be harvested.

# Thermal and Physical Properties of Fuel Briquettes Made from Agricultural and Other Waste Products

By Jefferson B. Rodgers

AGRICULTURE is often referred to as the world's most wasteful business. The percentage of the gross agricultural production actually used for food purposes is low. The remainder is largely waste material which is put to little or no use, and is more often than not a burden to farmers. Fibrous materials such as straw, cornstalks, corncobs, and hulls, make up the bulk of the waste materials, which are disposed of generally by wasteful burning.

A common sight in the fall of the year after the harvesting operations are over, particularly in the northwestern states, is a sky reddened at night by burning straw stacks and stubble fields. Waste straw, a burden to the farmer, is being burned annually to the extent of hundreds of thousands of tons in order to clear the fields before plowing and seeding for the coming year. If the heat generated by the burning straw could be stored and used during the cold winter months, this burning would be justified. The other alternative is to store the straw and use it as fuel to supplement the costly fuels which are now in common use.

The development of a machine to utilize successfully the dry waste products of the lumber manufacturing industry, particularly planer shavings, sawdust, and hogged chips, by forming them into fuel briquettes which are sold under the trade name of "Pres-to-logs," has brought to the attention of those interested in agricultural waste utilization the possibility of using the same or a similar machine to produce fuel briquettes from straw and other agricultural waste products.

The purposes of this study were (a) to make a study of the "Pres-to-logs" machine in order to determine whether the machine in its present form, or with modifications, could be used for making fuel briquettes from agricultural waste products; and (b) if the machine were successful in producing briquettes from such materials, to determine the thermal, physical, and burning characteristics of these briquettes.

Divisions of this study were as follows: (1) producing fuel briquettes; (2) preparing samples from briquettes and their use for heat value determinations; (3) conducting boiler tests using different fuels; and (4) determining the percentage of moisture and the quality of the bond.

## PRODUCING FUEL BRIQUETTES

Through the courtesy of Wood Briquettes, Inc., Lewiston, Idaho, all briquettes used for this study were made by the "Pres-to-logs" machines at the company's plant in Lewiston, Idaho.

In the manufacture of briquettes the waste material is first processed by being ground in a hammer mill to uniform size. The screen in the hammer mill has one-quarter-inch openings. The material is then elevated by means of a blower elevator to overhead storage bins, from which it is delivered to each Pres-to-logs machine through a conveyor pipe. By the time the processed raw material reaches the machines, it is thoroughly mixed and the material in any small section of a briquette is representative of the material in the entire briquette. Since the raw material is so thoroughly mixed before the pressing operation, a representative sample may be obtained by taking a small section of a briquette, free from all foreign material that might cling to the surface, and by grinding or other means, reduce it to a mass of finely ground material.

The Pres-to-logs machine was designed and developed to utilize dry lumber waste products; however, this study showed that the machine could handle agricultural waste products as satisfactorily as it now handles dry lumber wastes. The machine was altered in no way for the production of the special briquettes. Some difficulty was experienced in making briquettes from materials having a moisture content exceeding 10 per cent. This, however, was not the fault of the machine, but was due rather to inadequate preparation of the raw material. The engineers who designed and developed the machine are confident that with a few alterations it can be made to handle straw and other waste products even more satisfactorily than it does at present. The alterations would be of a minor nature, consisting of a slight change in the lead of the tip or pressing screw, and a change to a coarser screen in the hammer mill: Experience indicated that agricultural waste material should not be ground as fine as dry lumber waste. Results also seemed to indicate that if the lead of the tip were decreased slightly, more satisfactory briquettes could be produced. With some materials a tapered die gives more satisfactory

TABLE 1. HEATING VALUES OF FUEL BRIQUETTES

| Sample No. | Material | Heating Value in Btu per Pound: First trial | Second trial | Third trial | Average |
|---|---|---|---|---|---|
| 1 | Coal and wood (50-50 by volume) | 10,369 | 10,356 | 10,361 | 10,362 |
| 2 | Redwood bark | 7,190 | 7,225 | 7,186 | 7,200 |
| 3 | Redwood | 8,393 | 8,504 | 8,521 | 8,473 |
| 4 | Alfalfa | 7,364 | 7,538 | 7,508 | 7,470 |
| 5 | Oat straw | 7,016 | 7,138 | 7,164 | 7,106 |
| 6 | Peat | 8,899 | 9,056 | 9,065 | 9,007 |
| 7 | Newspaper | 8,021 | 8,121 | 8,099 | 8,080 |
| 8 | Pea straw | 7,003 | 7,073 | 7,121 | 7,066 |
| 9A | Wheat straw | 6,947 | 6,995 | 6,999 | 6,980 |
| 9B | Wheat straw | 6,973 | | | 6,973 |
| 10A | White pine | 8,347 | 8,317 | 8,282 | 8,315 |
| 10B | White pine* | 8,317 | | | 8,317 |
| 11 | Cane (bagasse) | 7,943 | 7,969 | 7,925 | 7,946 |
| 12 | Almond shells and white pine (50-50 by volume) | 8,230 | | | 8,230 |
| 13 | Almond shells | 8,364 | | | 8,364 |
| 14 | Ponderosa pine | 8,577 | | | 8,577 |
| 15 | Blue stain lumber | 8,577 | | | 8,577 |
| 16 | Incense cedar | 8,486 | | | 8,486 |
| 17 | Guayule | 8,077 | | | 8,077 |
| 18 | Chestnut | 7,895 | | | 7,895 |
| 19 | Rice hulls | 6,074 | 6,152 | | 6,113 |
| 20 | Apricot pits | 8,521 | | | 8,521 |
| 21 | Peach pits | 8,209 | | | 8,209 |
| 22 | Douglass fir | 8,431 | | | 8,431 |
| 23 | Sagebrush | 8,186 | | | 8,186 |
| 24 | Quebracho | 8,143 | | | 8,143 |
| 25 | Pea hulls (pea bran) | 6,881 | | | 6,881 |

*Used as fuel for boiler tests

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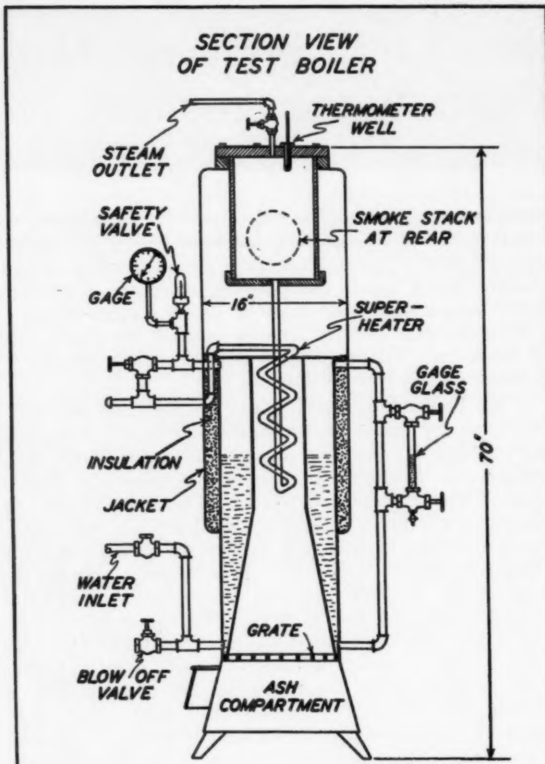


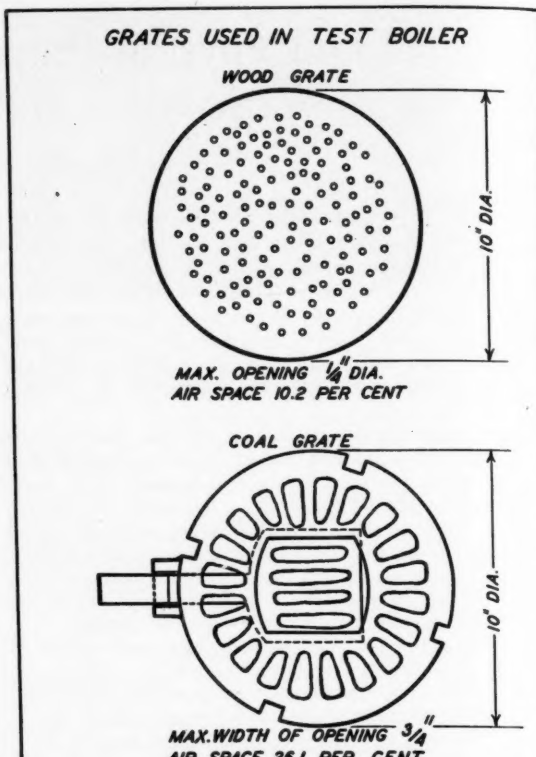


FIG. 1 (LEFT) SECTIONAL VIEW OF TEST BOILER. FIG. 2 (RIGHT) GRATES USED IN THE TEST BOILER

results than the straight die which is used for white pine wood wastes. With the changes mentioned, the machine could be made to handle materials which have a higher moisture content. The straw could then be hauled directly from the fields to the plant to be ground and pressed into briquettes without the necessity of a drying operation. The machine and operation as developed for and applied to the utilization of wood wastes is described in greater detail following the report of this study.

PREPARING SAMPLES FROM BRIQUETTES

The samples used in the bomb calorimeter were obtained by making several saw cuts through the entire briquettes. The sawdust was collected on a clean sheet of paper and thoroughly mixed. The "quartering" method was then employed to obtain the small representative sample used in the bomb calorimeter. The samples thus obtained were kept in tight cans until tested in the calorimeter. Since the samples were not dried, the heating values are reported in British thermal units per pound "as fired." The bomb calorimeter was operated according to standard practice.

The heating value on an "as fired" basis of the various materials which were formed into briquettes is reported in Table 1. In some cases as many as three determinations were run on the same sample. A Parr oxygen bomb calorimeter was used for making the heat value determinations, and no correction was made for the nitric and sulphuric acids formed as a result of combustion.

A total of 25 heat value determinations were run on as many different materials. The heating values of agricultural waste materials in order from high to low ran as follows: apricot pits, almond shells, a mixture of almond shells and white pine, peach pits, sagebrush, quebracho, guayule, bagasse, alfalfa, oat straw, pea straw, wheat straw, pea hulls, and rice hulls. Some of the materials have a rather poor bond. To improve the bond, these materials are mixed with wood waste in equal volumes. This gives a much better bond and does not materially alter the heating value.

BOILER TESTS OF FUELS OF BRIQUETTED WASTES

The boiler used was a small one designed to be used in the heating system of a small house. It had been modified by the addition of an insulating jacket and a superheater, as shown in Fig. 1. In conducting the boiler tests the American Society of Mechanical Engineers' test code for stationary steam boilers was followed in so far as it was possible to do so.

To secure equality of conditions the furnace was well heated by a preliminary run at the combustion rate to be used during the test. After the furnace was thoroughly heated, the fire was cleaned and the thickness and condition of the fuel bed noted. The height of water in the boiler was marked by tying a string on the gauge glass. Other quantities recorded were steam pressure, superheated steam temperature, flue gas temperature, and feed water temperature. All conditions were approximately the same for the various tests so the results obtained are comparable. The fuel was hand-fired and carefully weighed. At various times during each of the tests the flue gas was analyzed by means of a standard Orsat apparatus. The duration of each test was five hours. An attempt was made to have conditions at the end of the test the same as at the beginning.

Boiler tests 1 and 2, the results of which are reported

TABLE 2. BOILER TEST RESULTS

| Test No. | Fuel | Average gauge pressure, lb | Average super-heat, deg F | Average flue gas tempera-ture, deg F | Weight of $H_2O$ evapora-tion, lb | Weight of fuel used, lb | Per cent ash | Flue gas analysis, per cent (average) $CO_2$ | $O_2$ | CO | Boiler efficiency, per cent | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Coal | 23.00 | 106.08 | 429.00 | 104.50 | 32.50 | 4.60 | 5.97 | 13.74 | 0.37 | 29.8 | Coal grate used, no damper in flue |
| 3 | Coal | 18.20 | 187.89 | 444.50 | 146.00 | 30.00 | 3.40 | 12.07 | 5.50 | 0.36 | 46.6 | Coal grate used, damper in flue |
| 5 | Coal | 18.00 | 209.70 | 598.00 | 146.25 | 31.00 | 4.84 | 12.39 | 5.61 | 0.70 | 45.5 | Coal grate used, damper in flue |
| 2 | Briquettes (white pine) | 21.86 | 299.80 | 487.00 | 147.75 | 58.25 | 0.86 | 5.05 | 15.14 | 0.08 | 39.4 | Coal grate used, no damper in flue |
| 4 | Briquettes (white pine) | 18.48 | 311.54 | 665.95 | 138.25 | 50.50 | 0.74 | 16.28 | 2.92 | 0.80 | 42.8 | Coal grate used, damper in flue |
| 6 | Briquettes (white pine) | 19.33 | 313.40 | 697.00 | 143.25 | 52.00 | 0.72 | 16.38 | 2.70 | 0.80 | 43.2 | Coal grate used, damper in flue |
| 10 | Briquettes (white pine) | 22.52 | 281.05 | 632.00 | 131.00 | 46.75 | 0.54 | 15.64 | 3.77 | 0.34 | 43.3 | Special grate used, damper in flue |
| 7 | Wood fir | 21.43 | 247.22 | 634.00 | 127.50 | 50.50 | 0.49 | 10.78 | 9.18 | 0.00 | 40.2 | Coal grate used, damper in flue |
| 8 | Wood fir | 21.05 | 261.78 | 667.75 | 126.50 | 50.25 | 0.75 | 11.54 | 8.45 | 0.00 | 40.2 | Coal grate used, damper in flue |
| 11 | Wood fir | 23.48 | 282.22 | 631.43 | 135.63 | 54.25 | 0.46 | 12.87 | 7.37 | 0.05 | 39.9 | Special grate used, damper in flue |
| 9 | Briquettes (wheat straw) | 21.45 | 283.19 | 649.25 | 129.75 | 47.00 | 3.72 | 10.51 | 9.60 | 0.00 | 50.6 | Coal grate used, damper in flue |

in Table 2, using coal and white pine briquettes, respectively, as fuel, were conducted with the boiler equipped with a coal grate and with no damper in the flue. A damper was installed and tests 3 to 9 were run. A coal grate was used for this series of tests. A special grate, consisting of a steel plate perforated with 163 one-fourth-inch holes and designed to be placed on top of the coal grate (Fig. 2), was constructed and tests 10 and 11 were run. Damper and grate conditions were altered in order to determine the most efficient means of burning the briquette fuel.

To determine the burning characteristics of the various fuels and the boiler efficiency when these materials are used as fuel, a series of 11 boiler tests were conducted. The essential data secured as a result of the boiler tests, together with calculated quantities, are reported in Table 2. An attempt was made to keep all the conditions approximately the same for the boiler tests in order that the results obtained might be comparable.

As will be noted from Fig. 1, the test boiler was altered considerably. The height of the boiler was increased by placing an old hot water tank around the original boiler and allowing it to extend up far enough to make room for a steam retort and superheating coil. The boiler is rather poorly insulated and as a result the radiation and other unaccounted for losses were high. Fig. 3 is a diagrammatic drawing of the test boiler and other apparatus used in conducting the boiler test.

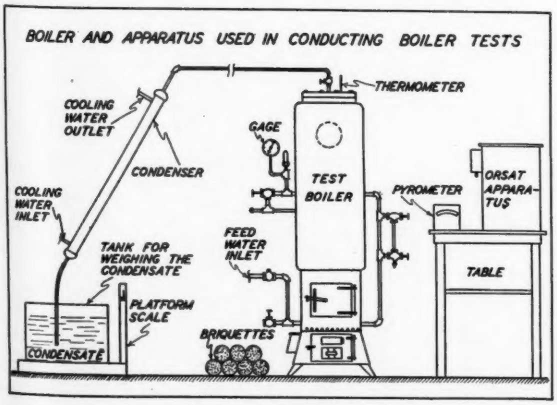


FIG. 3 DIAGRAM OF BOILER TEST APPARATUS

A typical heat balance was prepared showing the distribution of heat and the boiler losses. Boiler test 5, using coal as fuel, and test 6, using wood briquettes as fuel, are the basis on which the heat balance chart was prepared. (Table 3).

### THERMAL CHARACTERISTICS

In general, the heating value of briquettes made from shells and pits is higher than the heating value of briquettes made from straw, as will be seen by an inspection of Table 1. The heating value of straw briquettes averages several hundred Btu (British thermal units) per pound less than briquettes made of wood. The burning characteristics of wheat straw briquettes more nearly approximate those of coal than briquettes made of wood. Wheat straw briquettes do not disintegrate as readily as wood briquettes in the furnace or stove, but maintain their original form a greater length of time, more nearly as a lump of coal would do under similar conditions. Under the conditions of the boiler tests run, wheat straw fuel gave the highest boiler efficiency of any of the fuels tested, as will be seen by reference to Table 2. Wheat straw fuel has a tendency to clinker when a deep fuel bed is maintained in the furnace. It burns efficiently, as will be seen by an inspection of the flue gas analysis reported in Table 2.

If briquette fuels are to be burned efficiently in stoves or furnaces, regardless of the material from which the briquettes are composed, certain conditions are desirable. First of all, the fire door and drafts must fit tightly if the fire is to be regulated closely. Briquette fuel should be burned on a wood grate or an improvised grate which reduces the area and the maximum size of the openings in the grate. This is important as heat causes the briquette

TABLE 3. HEAT BALANCE (SHORT FORM)

| Item | Name of Loss | Boiler Test No. 5, Fuel: Coal, Btu | Per cent | Boiler Test No. 6, Fuel: Wood briquettes, Btu | Per cent |
|---|---|---|---|---|---|
| | Heating value of fuel "as fired" (by calorimeter test) | 12,961.0 | | 8,317.0 | |
| 1 | Heat absorbed by water and steam in boiler and superheater | 5,900.0 | 45.50 | 3,590.0 | 43.20 |
| 2 | Heat loss due to moisture in coal | 144.5 | 1.11 | 120.0 | 1.44 |
| 3 | Heat loss due to water from combustion of hydrogen | 710.0 | 5.48 | 729.0 | 8.76 |
| 4 | Heat loss due to moisture in air | 30.4 | 0.24 | 37.0 | 0.44 |
| 5 | Heat loss due to dry chimney gases | 1,640.0 | 12.60 | 775.0 | 9.32 |
| 6 | Heat loss due to incomplete combustion | 404.0 | 3.12 | 263.0 | 3.16 |
| 7 | Heat loss due to unconsumed combustible in refuse | 166.0 | 1.28 | 44.2 | 0.53 |
| 8 | Heat loss due to radiation and all other losses | 3,966.1 | 30.67 | 2,758.8 | 33.15 |
| | Total | 12,961.0 | 100.00 | 8,317.0 | 100.00 |

to crumble and if the openings in the grate are large, too much of the fuel will fall through to the ash pit unburned. The third requirement for burning briquettes efficiently is to have a damper in the smoke pipe or stack leading from the boiler. This makes it possible to regulate the air drawn through the furnace, and thus control the rate of burning. Boiler tests 1 and 2 were run with no damper in the flue, and as a result the boiler efficiency is lower than for the remainder of the tests which were run with a damper in the flue. The special grate illustrated in Fig. 2 was used for tests 10 and 11. However, results were not materially different from the other tests, except that it was much easier to control and regulate the fire.

A boiler heat balance chart was prepared and the results are reported in Table 3. Tests 5 and 6 were selected because the former is typical of the tests run using coal as the fuel, and the latter is typical of the tests in which wood briquettes were used as a fuel. One item appearing in both tables needs more explanation and comment. Item 8, which is the heat loss due to radiation and all other losses, is high owing to the fact that the improvised jacket permitted some air leaks, and, in addition, presented a large radiation surface for the loss of heat. As stated elsewhere in this report, the original boiler was changed considerably. The height was increased to permit the installation of a superheater and a steam retort. The jacket for the boiler addition was an old hot water tank which did not fit tightly and is rather poorly insulated. As a result of the added radiation surface and air leakage, item 8 is high.

### MOISTURE CONTENT AND QUALITY OF BOND

Moisture determinations were made by drying samples in an oven until they reached constant weight, and then expressing the percentage of moisture on an air-dry basis.

Owing to the nature of the process, no data could be taken during the production of special briquettes from the 25 different materials. The Pres-to-logs machines were carefully observed while the special briquettes were being manufactured, to determine if they could handle successfully agricultural waste material. Observations and results showed that the machines will handle agricultural waste material as successfully as they handle wood waste. The straw was processed in the same manner as the dry lumber waste products, and the machine was not altered in any way for making straw briquettes. The only difficulty experienced in making briquettes from straw was in cases where the moisture content of the straw exceeded 10 per cent. When the moisture content of the raw material is excessive, the heat of compression generates sufficient steam and gas to cause small explosions in the dies as the material is being formed into briquettes. This causes the surface of the briquette to be rough, and, in general, lowers the quality of the briquette. If the moisture content of the raw material is lowered by drying to approximately 8 per cent, no difficulty is experienced in making briquettes from straw.

It is difficult to compare the quality of the bond in the various briquette samples, as there seems to be no test or means of expressing qualitatively the binding quality of the material when formed into briquettes. One of the best means of determining the bond relatively is by a visual inspection and examination. An attempt was made to express the quality of the bond on the basis of the compressive load necessary to cause failure of the test sample. Samples were tested to failure in compression in the Olson Universal testing machine. The samples were approximately 4.125 inches in diameter and 8.25 inches long. The load was applied at the rate of 0.125 inches per minute. With one exception, the briquettes made from agricultural waste

TABLE 4. MOISTURE AND COMPRESSIVE LOADS

| Sample No. | Material | Total compressive load to cause failure*, lb. | Load per square inch to cause failure, lb. | Per cent moisture (air dry basis) | Remarks |
|---|---|---|---|---|---|
| 1 | Wood and coal briquette (50-50 by volume) | | | 3.60 | Poor bond |
| 2 | Redwood bark briquette | | | 11.68 | Poor bond |
| 3 | Redwood briquette | | | 6.08 | Good bond |
| 4 | Alfalfa briquette | | | 8.96 | Excellent bond |
| 5 | Oat straw briquette | | | 10.16 | Excellent bond |
| 6 | Peat briquette | | | 23.94 | Very poor bond |
| 7 | Newspaper briquette | | | 7.40 | Very poor bond |
| 8 | Pea straw briquette | | | 10.22 | Excellent bond |
| 9A | Wheat straw briquette | 71,290 | 5,340 | 6.70 | Excellent bond |
| 9B | Wheat straw briquette | 57,520 | 4,310 | 8.00 | Excellent bond |
| 10A | White pine briquette | 65,600 | 4,910 | 8.90 | Good bond |
| 10B | White pine briquette | 69,900 | 5,225 | 8.50 | Good bond |
| 11 | Bagasse briquette | 116,700 | 8,740 | 5.50 | Excellent bond |

*All briquette specimens tested in the Olson Universal testing machine were 4⅛ inches in diameter and 8¼ inches long. Load was applied at the rate of ⅛ inch per minute.

products withstood a greater compressive load before failing than did the briquettes made from dry lumber wastes. In general, it is safe to say that the briquettes made from straw are superior to those made from planer shavings on the basis of the quality of the bond. Table 4 gives the percentage of moisture, compressive loads, and remarks concerning the bond as determined by a visual inspection and examination.

Fibrous agricultural waste products, as for example, the various straws, bagasse, guayule, etc., are excellent raw materials from which to produce fuel briquettes by the Pres-to-logs process. Briquettes made from these wastes have an excellent physical structure, being very hard and dense with a specific gravity of approximately 1.3. The bond which holds the material together in the form of a briquette, purely a frictional bond, is superior to the bond of the briquettes made from wood waste. (Table 4.) Briquettes made from agricultural wastes do not crumble or break as easily as briquettes made from wood waste. This gives the former a decided advantage from the standpoint of handling and storing. Briquettes should be stored in a dry place as moisture weakens the bond, causing them to lose their original form. Briquettes have been stored in cellars for weeks without seriously weakening the bond or causing any appreciable crumbling; however, the direct application of even a small amount of water, as, for example, a drip from a leaky roof, quickly causes a briquette to crumble and fall apart. Fig. 5 shows the effects of a direct application of water on an alfalfa briquette.

Briquettes made from almond shells, peach pits, apricot pits, peat, newspapers, and coal, have a very weak bond, crumble easily, and cannot be handled or stored with the same ease as other briquettes.

As a result of this study, two very definite conclusions may be inferred, namely, (a) the Pres-to-logs machine, without any alterations, can be used for manufacturing fuel briquettes from fibrous agricultural waste products; and (b) agricultural waste products, as, for example, wheat straw, oat straw, pea straw, bagasse, etc., are excellent raw materials from which to produce briquette fuels by the pres-to-logs process.

### BRIQUETTING ALFALFA

Briquettes were made of alfalfa hay and pea hulls (pea bran) with no thought of using either as fuel, but to determine whether or not they would make suitable briquettes. Alfalfa hay compressed into briquettes could be used by poultrymen to supply their flocks with green feed during the winter months. A briquette placed in a pan containing a small amount of water quickly disintegrates to the point where chickens can eat it. Fig 5 shows the effect of moisture on an alfalfa briquette. Compressing stock feed, as, for example, pea hull bran, into briquettes would be a very convenient means of storing and shipping such feed. A ton of briquettes can be stored in a space of 30 cubic feet, as compared with 80 cubic feet for baled hay, 135 cubic feet for chopped hay, and 500 cubic feet for loose hay.

In general, the heating value of agricultural waste products compares very favorably with wood waste. The heating value of the various straws is somewhat lower than the heating value of wood waste. In spite of the lower heat value, straw briquettes are a very satisfactory fuel, as was indicated by the boiler tests. Under the conditions of the boiler tests wheat straw briquette fuel resulted in the highest boiler efficiency of any of the fuels used.

This study has shown that most agricultural waste products when compressed in the form of briquettes make a very satisfactory fuel with heating values comparable to wood. The Pres-to-logs machine and process afford a ready means of manufacturing fuel briquettes from agricultural wastes. Such machines may be leased and located in centers where large amounts of waste material are available, and through this medium agricultural waste material can be transformed into useful fuels to supplement and conserve the fuels now in common use. In addition to this, the agricultural industry would be benefitted by having an outlet for the waste material which at the present time brings in little or no return.

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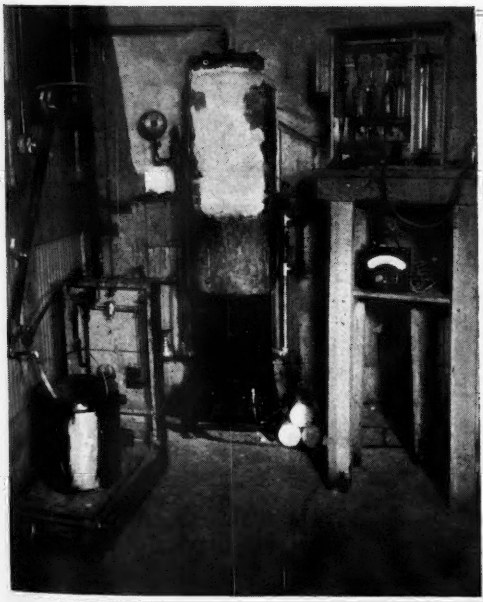
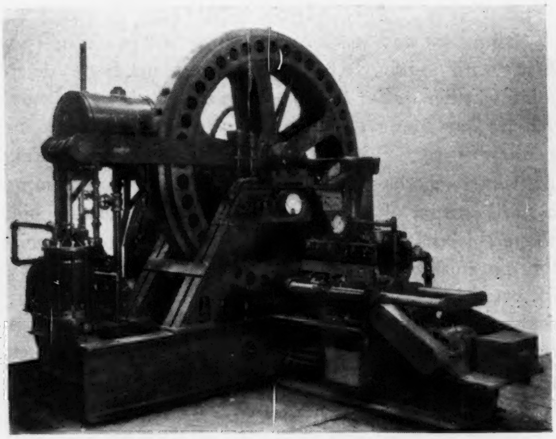


FIG. 4 (LEFT) TEST BOILER AND APPARATUS USED IN CONDUCTING BOILER TESTS

FIG. 5 (BELOW) THE EFFECT OF A DIRECT APPLICATION OF WATER ON AN ALFALFA BRIQUETTE



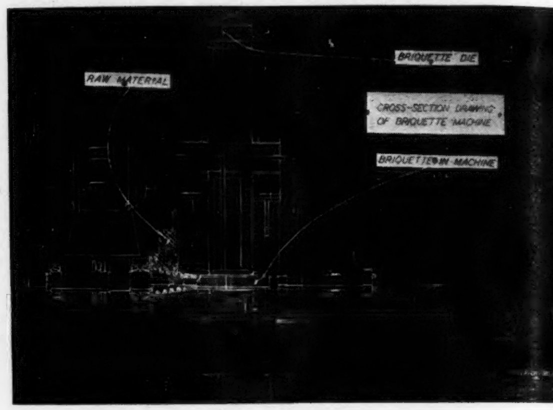



FIG. 6 (LEFT) THE "PRES-TO-LOGS" MACHINE. FIG. 7 (RIGHT) A CROSS SECTION OF THE SAME MACHINE

## The "Pres-to-Logs" Machine and Fuel Producing Operation

"Pres-to-logs" are a cylindrical or log-shaped fuel measuring 4 inches in diameter and 12½ inches long. Each log weighs approximately 8 pounds. They are produced from dry planer shavings, sawdust, hogged chips, and other fibrous waste materials. These materials are subjected to enormous pressure in the dies of the machine and no binder of any kind is added to cause the material to bond together. The log as it leaves the machine is a very dense, highly concentrated fuel, more than three times as heavy as wood and so dense that it will not float in water. The machine which produces these fuel logs is a machine of extraordinary power and strength, as will be seen by reference to Figs. 6 and 7.

The essential parts of the Pres-to-logs machine are the pressing screw, the die, and the pressure-regulating cylinder. These parts may be seen by referring to Fig. 7.

The raw material used in the manufacture of pres-to-logs, consisting essentially of clean, dry planer shavings, sawdust, and hogged chips, is delivered to the pres-to-logs department from the planing mill and other dry lumber manufacturing departments by means of a blower conveyor system. The material is then ground to uniform size in a hammer mill and elevated to an overhead storage bin by means of a blower elevator. From the storage bin the material is carried by a conveyor pipe to each Pres-to-logs machine. The raw material is forced by the tapered spiral compressing screw into the cylindrical openings of the die wheel. As each die is filled, the die wheel rotates to the next opening to be filled. As the material is forced into a die a cooled pres-to-log is forced out of the die against the action of the pressure-regulating cylinder. During the pressing operation the spiral compressing screw, or tip, as it is called, develops a pressure of 165,000 pounds. The compressing screw is driven by a 30 or 40-horsepower motor, depending on the material to be compressed. Considerable heat is generated during the pressing operation, which makes it necessary to construct the die wheel so that cooling water can be circulated around each of the 40 chromium alloy steel dies.

The die wheel is a massive steel casting 7 feet in diameter. The die wheel is turned or indexed by a hydraulic cylinder, which in turn is actuated by a pump driven by a 10-horsepower motor. The pressure necessary to index the die wheel and shear off the pres-to-log under compression is from 30,000 to 40,000 pounds.

The function of the pressure holding cylinder is to control the uniform density of the pres-to-log in its formation; while material for a new pres-to-log is being forced into the die, a cooled "log" is being forced out against the piston of the pressure-regulating cylinder. The pressure in the cylinder is automatically regulated, thus insuring a uniform density throughout each pres-to-log. When the cooled pres-to-log has been completely unloaded from the die, the pressure cylinder is released, allowing the log to drop away; the die wheel is then indexed and the pressure cylinder forces the piston rod back against the die face. A ¾-horsepower motor through a set of reduction gears actuates the pressure-regulating piston.

The Pres-to-logs machine is completely automatic in its operation; however, each machine is equipped with a set of manual controls enabling the operator to take the complete machine or any part out of automatic operation. The capacity of each machine is one pres-to-log every 30 seconds, or 10 tons per day of 24 hours.

With the permission of Wood Briquettes, Inc., Table 5 is included giving the power and labor costs for a single and for a twin machine installation.

TABLE 5

| Number of machines installed | 1 machine | 2 machines |
|---|---|---|
| Daily production | 10 tons | 20 tons |
| Power used for each Pres-to-log machine, 480 kilowatt-hours per 24-hour day at $0.01 | $ 4.80 | $ 9.60 |
| Power used for grinding with direct-connected fan (one grinder used for any number of machines differing only in size) | $ 2.40 | $ 3.60 |
| Operators for 24 hours at 40 cents per hour (one man will handle one or two machines) | $ 9.60 | $ 9.60 |
| Total | $16.80 | $22.80 |
| Average per ton | $ 1.68 | $ 1.14 |

# Engineering Phases of Soil Erosion Control

*A Symposium*

## Terrace Project Planning

By C. L. Hamilton

THERE is considerable difference of opinion as to where the planning work on a terrace project should start. Should the engineer take a part in, or be concerned with, the preliminary plans used in developing the correct land-use program, the preliminary educational work necessary, and the arrangements or organization necessary for promoting the most adaptable type of equipment, etc. These are points that have not been decided as yet by our subcommittee. For that reason, the following material deals only with some of the more general engineering considerations necessary in developing the field plans for a successful terracing project. For this preliminary report it has been taken for granted that the correct land-use policy with supplementary cropping plans has been worked out for the area under consideration, and that terracing is necessary to provide an effective erosion control plan. It should also be understood that none of the actual construction details have been included in this paper.

One of the most important factors in the success of a terrace project is the type and training of the man in charge of the field planning work. While certain fundamental engineering training is essential, a high degree of theoretical training is not as important as the faculty of good sound judgment combined with an agricultural background and general understanding of the various phases and measures of erosion control. Says C. E. Ramser, "The technique of soil erosion control by terracing is founded upon two basically engineering subjects—drainage and the dynamics of erosion. Drainage involves a knowledge of the fundamental principles underlying rainfall, runoff, and hydraulics; and erosion, a knowledge of mechanics and hydraulics in their relation to the dynamics of flowing water. The practice of terracing and outlet control requires an intimate knowledge of two other engineering subjects—surveying and construction."

The fundamental engineering training should consist of hydraulics, hydrology, surveying, and construction as applied to erosion control. The engineer should also have good sense of economy and practicability as well as a working knowledge of agricultural work in order to effectively design and correlate terracing work with other erosion control measures and appreciate the farm problems involved. Usually the more experience the planning engineer has had in the above fields of work, the more successful he should be in carrying out the work involved in terrace project planning.

The equipment necessary for terrace project planning will usually consist of at least a level, a measuring chain, and a field note book. The addition of a compass, plane table, or transit is often desirable, and particularly so when a higher degree of accuracy is required or where a large amount of work is to be done. The final selection of the equipment will usually vary slightly with the choice and experience of the individual engineer in charge of the field work.

### RECONNAISSANCE SURVEY AND PRELIMINARY MAP

The first step in planning a terrace system for any area is to make a thorough physical inspection of the area under consideration, and, for the larger projects, prepare a sketch map locating all the topographical features such as drains, ridges, slopes, hills, gullies, field and property lines, roads, buildings, fences, or any other features that may influence the design of a terrace system. A reconnaissance of the areas to all sides should also be made and the type of vegetation and size of drainage both on the terracable area and to either side should be determined. The location and size of culverts, gullies, and drains below the watershed are features to be included.

If a sketch map is used, it need only have reasonable accuracy and may vary all the way from a map prepared from information secured by a physical inspection, a hand level and pacing, to a complete transit topographic map with all contours of the terrain. The use and need for a field map will depend upon the experience of the field men,

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Author: Soil Conservation Service, U. S. Department of Agriculture. Jun. Mem. ASAE.

the size of the project, and the nature of the topographical features encountered. Engineers with years of field experience may often dispense to advantage with the actual preparation of the field map, where the topographical features encountered are not difficult. The preparation of the map, however, will usually be of material value to younger engineers who lack experience, and on areas difficult to terrace. Insufficiently considered and hastily prepared plans usually result in unsatisfactory layouts. The importance of determining the most satisfactory preliminary plans is realized from the fact that terraces once constructed become permanent with proper maintenance, and relocation is a costly and difficult procedure.

From a study of the field notes and observations, together with the soil type, precipitation, and type of farming in the area, the most satisfactory terracing plan can usually be determined for the area under consideration. All necessary terracing units or systems for the entire area should be considered, and a plan developed so that any terracing that is done will be a part of a planned program that can be fitted together without difficulty when the construction work is completed. The field engineer should keep in mind the possible rearrangement of fields, fences, roads, etc., to conform to erosion control and good farm management policies.

The location of the most desirable terrace outlet is one of the first steps that should be decided in developing the preliminary plans, because the final location of the various terraces is usually determined by the topography of the area and the location of the most satisfactory outlet. After the necessary outlets are located the terracing system should be developed around the outlets in such a way as to match the topography and use of outlets most satisfactorily and economically.

### GENERAL PRINCIPLES TO BE OBSERVED IN THE FINAL PLANNING OF A TERRACING PROJECT

The following general principles should be observed in deciding upon the final plan of a terracing project:

1 Terracing is usually only one phase of erosion control work on cultivated land, and its use must be correlated with a proper land-use policy as well as the other erosion control measures for most satisfactory results. All preliminary terracing plans should therefore be developed so that the final work will be consistent with proper land use and any other erosion control measures necessary on the same area. Wherever soils, farm management, or agronomy specialists are assigned to develop their respective phases of the erosion project, all preliminary erosion control plans should be developed cooperatively and correlated with each subject matter specialist concerned.

2 Since terracing is fundamentally a surface drainage problem, it should be planned according to drainage units. A drainage unit should be considered as the maximum area that can be drained into one outlet or one system of outlets. Such topographical features as ridges, drains, roads, large gullies, abrupt changes in slopes, maximum length of terraces, etc., should be the main features in determining boundary lines or divisions between various drainage or terracing units. Under certain conditions it may be necessary to divide otherwise satisfactory terrace units into smaller ones because of field or property lines, fences, timber, crops or pastures, etc., but this practice should be avoided whenever possible because it usually results in a more expensive or less desirable system of terracing.

3 Terrace outlets should be located where they can be constructed and maintained most economically and where they will function most satisfactorily, with preference being given to the gentler slopes and to field or property lines where outlets would give minimum interference with field cropping or tillage practices. The possibility of satisfactorily discharging individual terraces on firm sod or good forested areas should not be overlooked. A forested area, however, is usually not satisfactory, unless the grade is quite flat and some spreading device is used to prevent runoff concentration and washing of forest litter. In estimating or comparing the cost of possible outlets, the cost of outlet per acre of land served by the outlet should be used as a basis. The cost should include all construction and protection costs necessary to conduct the runoff water to a stabilized waterway, as well as the cost of maintenance work that can be expected over a definite period. The most economical outlet ditch is usually that which has terraces of maximum permissible length discharging into both sides of the outlet channel and where the construction and maintenance costs are reduced to a minimum. Road ditches and large or crooked gullies should seldom be used for a terrace outlet ditch because of the difficulty and cost of construction involved in necessary protection and maintenance work. A general policy of terracing water away from such locations is usually advisable.

4 All outlet channels should be as straight as it is practicable to make them. If bends are necessary in outlet channels with vegetative control, they should be long sweeping curves. In outlets requiring permanent check dams, any necessary changes in alignment should be made at a structure. The head wall of a structure at a turn should be at right angles to the center line of the channel leading to the next structure below.

5 The terraces from opposite sides of an outlet ditch should usually discharge into the outlet directly opposite each other, so that any outlet check dams or spreaders can be located between the terraces with their head wall extensions extending into each respective terrace ridge.

6 Every effort should be made to design the terracing system so that it will provide the most satisfactory erosion control (sheet and gully) and offer a minimum of obstructions or hindrances to the efficient operation of machinery and tillage practices that will be necessary on the area. Where gullies have formed, the terraces should be used to reclaim the gullied area or check further recession by proper diversion of runoff wherever practical. Every effort should also be exerted to provide as far as practical all features in the design or layout that will simplify, reduce, or assure necessary maintenance and protection of the terraces or outlets.

7 When a terrace collects runoff from an unterraceable area which will be in excess of the terrace capacity, an intercepting ditch should be provided with sufficient capacity to carry all intercepted water at a non-erosive velocity to a stabilized outlet. It will usually be desirable to have these ditches parallel with the top terrace. They should not be used below a cultivated area when sheet erosion would cause silting in the ditch.

8 The runoff curves and tables from "Brief Instructions on Methods of Gully Control," by C. E. Ramser, should be used for calculating the rate of runoff and size of weir notches or channels required. Mr. Ramser's reduction ratio of 0.60 for 1 acre, 0.70 for 10 acres, 0.75 for 30 acres, and 0.90 for 100 acres, can be supplied for graded terraced areas. An additional reduction of about 25 per cent can also be made in estimating runoff from level terraced areas. Mr. Ramser feels that no reduction should be made for areas larger than 100 acres. Depth of flow and width of vegetative outlets can be computed from the curves or tables prepared by the USDA Bureau of Agricultural Engineering and the Soil Conservation Service.

### TERRACE SPACING, GRADES, AND LENGTH

After the preliminary field survey and plans have been made it will be necessary to determine the exact spacing, grades, and length of terraces that can be used for the project under consideration before the details of the system can be laid out in the field.

1 *Terrace Spacing.* The final terrace spacing used should provide a minimum of soil and water losses between terraces that is consistent with economical construction and practical tillage operations. Some of the factors which influence terrace intervals are (1) intensity and frequency of rainfall, (2) slope of terrain, (3) vegetal cover, (4) type of soil, (5) cropping practices, (6) length of time and season surface is exposed to erosion, etc. In the past it has not been found practical to assign definite values or relationships to each of these variables and treat each field as a separate problem. The problem is too complex for such a solution. The only reliable procedure is to interpret experimental data, using most satisfactory procedure from similar areas as a guide in the design.

Since experimental results indicate that soil losses increase with an increase in the length of slope, and since the velocity or erosive power of runoff increases several fold with an increase in the slope, the grade and length of slope between terraces will be two of the most important factors in determining terrace spacing. After the grade and length relationships are established slight variations can be made when necessary to provide for the other influencing factors. For example, on highly erosive soils the spacing would be decreased slightly and increased slightly in areas with more erosive resistant soils or where exceptionally good tillage practices and vegetal cover were provided. Such changes, however, should only be minor and only made after considerable investigation, because the type of soil only has a minor influence, if any, on runoff during rains of high intensity, or after the soil has become saturated; and the continuation of present vegetal cover or rotations cannot always be depended upon over a period of years.

As a result of the terrace spacing studies on the USDA soil erosion experimental farms, Mr. Ramser recommends the following spacing tables as guides for all terracing work on average cultivated land; any desirable variations from these spacings to provide for unusual local conditions should not be in excess of 20 per cent either above or below:

SOUTHERN STATES

| | | | | | | |
|---|---|---|---|---|---|---|
| Slope of land in feet per 100 feet | 1 | 2 | 4 | 6 | 8 | 10 |
| Vertical fall between terraces, feet | 2 | 2½ | 3 | 3½ | 4 | 5 |
| Distance between terraces, feet | 200 | 125 | 75 | 59 | 50 | 50 |

NORTHERN STATES

| | | | | | | |
|---|---|---|---|---|---|---|
| Slope of land in feet per 100 feet | 1 | 2 | 4 | 6 | 8 | 10 |
| Vertical fall between terraces, feet | 2 | 2¾ | 3½ | 4 | 4¾ | 5½ |
| Distance between terraces, feet | 200 | 137 | 88 | 67 | 59 | 55 |

The weighted average of all the slopes that a terrace is to cross should be used in computing the vertical terrace interval for each respective terrace, unless the topography is uniform. Where the slopes are uniform, the average slope of the area can be used in computing the vertical terrace interval to be used on all terraces for the area under consideration. On certain projects it might be necessary to reduce or increase the proper terrace interval slightly for certain terraces in the system, in order to get them in the most advantageous field locations, or it may be necessary to do some balancing between terrace intervals in order to get proper alignment of terraces at the outlet ditch.

2 *Terrace Grades.* Since experimental results show that both the rate of runoff and soil loss increases with increase in terrace grade the minimum grade that will provide satisfactory drainage should be used in the terrace channel. Since the variable-grade terrace will retard the rate of runoff and soil losses and provide sufficient drainage, it is usually superior to the uniform-grade terrace for all terraces above 200 to 300 feet in length.

In determining the final grade the total length of any terrace should be estimated and a variable grade established, which increases by uniform increments toward the outlet. Break grades at gullies, fills, or low spots wherever practical. Except for areas where level terraces are desirable, the upper end of a terrace channel should seldom be flatter than 0.05 feet per hundred feet of length, and the grade for the lower end of the maximum length terraces should seldom exceed 0.3 feet per hundred. In determining the final grade such factors as soil type, size and length of terrace, the need for complete drainage or moisture conservation, and other influencing field conditions should be taken into consideration and desirable minor variations made between the above limits.

In the semi-arid regions water conservation is one of the aims in terracing, although benefits in this connection are sometimes questioned. In these areas terraces can usually be constructed with very little grade and sometimes level with no fall in the channel. In the more arid sections wth open soils, terraces are sometimes constructed level and the ends closed to prevent any water leaving the fields. In general, the use of level terraces and particularly those with closed ends must be restricted to limit areas and soil conditions, and they should only be used after considerable investigation of both soil type and rainfall conditions, because arid sections are apt to experience rainfalls of high intensity and level terraces usually require more attention and maintenance than terraces with slight grades.

3 *Length of Terrace.* In general, 1800 feet should be considered the maximum distance that a terrace should drain water in one direction. When properly constructed and maintained one-half mile terraces will often give satisfactory service and these may sometimes be used sparingly to advantage in a terrace system in order to eliminate the need for a second outlet ditch. On gullied land a maximum length of 1500 feet should seldom be exceeded. When a few terraces in a system must exceed the maximum length recommendations, they are sometimes handled most satisfactorily by only draining the excess length in the opposite direction to a convenient natural or vegetative outlet.

### STAKING AND PLOWING OUT TERRACE SYSTEM

After the preliminary plan for terrace and outlet system has been decided upon, and the final terrace spacing, grades and approximate length selected, the engineer is ready to start the field staking for each terrace and outlet ditch in the system.

1 *Preliminary Staking.* Random stakes should first be set to mark the location and approximate width of the outlet ditch or ditches. The upper terrace is then staked using the ridge line of the hill as a starting point from which to measure the vertical interval for the first terrace. An exception to this rule might occur where it is desired to have a definite location for some particular terrace in the system. This terrace would then be located first and sufficient terraces staked between it and the ridge, so that the maximum vertical interval for any one terrace would not be exceeded and any reduction necessary in the spacing

of terraces would be divided proportionately. After the upper terraces are staked, each of the other terraces are staked in turn toward the bottom of the slope.

In order to get proper alignment of terraces at the outlet ditch, it will usually be found most convenient to start staking at the outlet end of the terrace, and the selected terrace channel grades will be used to locate all other stakes toward the upper end of the terrace. Stakes should be set at 50-foot intervals except on curves and through drains where a 25-foot spacing should be used. It is customary and usually most convenient to have the stakes indicate the location of the center line of the ultimate terrace ridge.

2 *Realignment of Terrace Lines.* After the terrace lines have been staked, some realignment is usually necessary on each proposed terrace in order to eliminate undesirable sharp curves and ultimately secure a finished terrace that will be most practical to construct, effective in checking soil losses, and offer a minimum of inconvenience in later field operations.

The realignment will vary both in type and amount with the topography of the field and will usually consist of moving certain stakes alternately up and down slopes where undesirable curves occur in terrace lines, until the most desirable terrace line that is consistent with all factors concerned is secured. Good field judgment must be exercised in order to secure the most satisfactory realignment of terraces.

The maximum movement of terrace lines up and down slopes will of necessity be limited to the drainage and construction features encountered. Usually the straightening of terrace lines should be limited in upward movement so that not more than 6-inch additional cuts will be necessary in the terrace channel. An exception may occur when a wide, sweeping bow can be eliminated by a slightly deeper cut, providing that other terraces of the system will follow uniformly. The straightening of terraces through drains must be limited to avoid excessive ridge height and pond area. Usually the maximum ridge height should not exceed three feet. If a gully has formed, the settled height of the ridge about the break into the gully should seldom exceed three feet.

IN THE REALIGNMENT OF TERRACES THE OUTLET END SHOULD BE TURNED DOWN GRADE

In the realignment of terraces it is usually found advantageous, and particularly so when the outlet is located in a natural draw, to turn the outlet end of the terraces down grade. With vegetative outlets, this down hill movement will allow better drainage of terrace outlets and allow for some silting before maintenance work is necessary. For vegetative outlets this movement should seldom exceed a vertical distance of 6 to 8 inches, or that which can be satisfactorily protected from channel erosion.

Where permanent check dams are used in the outlet, it is often desirable to have the terrace enter the outlet and locate the respective outlet check dam as much as one foot in vertical interval down grade from the usual location. The crest of the weir notch would be placed at the same elevation as would be used with the check dam in the upper or usual location. This will necessitate a slight increase in height of terrace ridge at the outlet end, but it will usually allow the terraces to enter the outlet ditch much straighter and reduce the excavation necessary in the outlet channel.

If the outlet ditch happens to be located so the terraces have a tendency to turn down hill near the ditch, they can usually be straightened considerably by a slight up-grade movement and some additional excavation in the terrace channel near the outlet end.

3 *Plowing Out Terrace Lines.* If a final check of the terrace and outlet locations show that the entire layout will be satisfactory, the terrace lines should be marked with a plow furrow since stakes are easily lost and more difficult to follow with the larger terracing equipment.

It is desirable to have the farmer or landowner go over the proposed terrace layout in detail, preferably plowing out the terrace lines himself, so he can fully visualize and agree to the complete layout. He should be informed of all the construction details necessary, particularly any extra work as fills in the terrace ridge or excavation in the outlet ditch. Before any terracing is done the owner should agree to farm with the terraces and maintain the terraces and outlets.

# Erosion Control in Terrace Outlets

By J. C. Wooley

IN A GREAT many instances it is necessary to discharge terrace outlet water into a road ditch or other water channel. The drop from the terrace to the ditch level varies from two to ten feet. It is necessary that this water be lowered into the ditch channel and the velocity destroyed. It is also necessary that the water be delivered from the terrace channel without any loss from seepage around the structure. One of the terraces for which an outlet structure was designed called for a rectangular notch 3 feet wide and 6 inches deep. The retaining walls extended back 3 feet on each side of the notch, and the cut-off wall, extending back and down at a 45-degree angle, was made 3 feet wide and 9 feet long, extending the full width of the structure on the upper side. (See Fig. 1)

This structure was made of rubble masonry laid up in concrete mortar and plastered. As an extra precaution against seepage, the earth was cut to shape for the structure and a coating of road oil applied before the concrete work was started. The flume carrying the water down the 45-degree slope was built of rubble masonry and plastered smooth.

At the bottom of the sloping section a semi-circular turnback was installed, using a 4-inch radius. This radius was selected after trials on a small model. It was found that this ratio between the depth of flow through the weir notch and radius of turnback was most effective. The semi-circular turnback was placed tangent to the floor of the flume. This part of the structure acts as a water cushion for small quantities and reverses the direction of flow when

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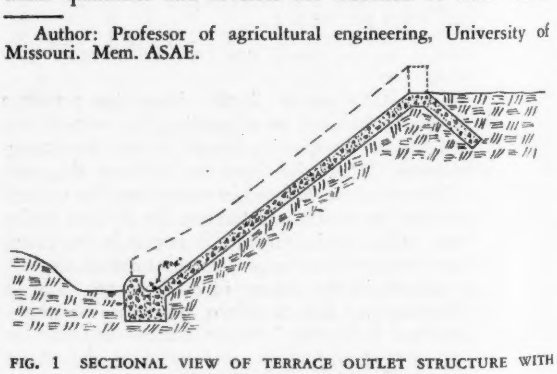


FIG. 1 SECTIONAL VIEW OF TERRACE OUTLET STRUCTURE WITH SEMI-CIRCULAR TURNBACK

running to capacity. The top of the turnback should be only slightly above the bottom of the ditch.

In the structure shown in Fig. 2, the turnback was placed up the slope and a water cushion located below. This has not been found necessary, however; and the turnback can be placed at the bottom of the sloping section without the water cushion.

In the case of the metal flume shown in Fig. 3, the upper part of the structure, including the cut-off wall and notch, was built the same as for the previous structure, the only difference being that the notch was 34 inches wide. The structure has been very effective in destroying velocity, as may be observed from the ditch below. There is no evidence that water entering the ditch from the structure has caused any change in direction of flow.

The addition of water from terraces to the road ditch has made it necessary to install some protective structures to prevent excessive erosion there. In the design of these structures it was desirable to reduce cost to the minimum, in order to make a structure that would not be conspicuous and one that would prevent damaging velocities. A thin-section concrete structure with a turnback to reduce velocity was designed. The fall secured in the structure itself varies from 12 to 18 inches, and the grade expected on the fill between structures is 1 per cent.

This structure (Fig. 4) is made by plastering a 2½-inch coating of 1:3 cement and sand on a puddled tamped base of clay. The side walls are plastered up to the desired height to form the notch needed. The turnback (Fig. 5) should be placed so that it will discharge the water at the level of the expected fill from the next structure below. Woven wire reinforcing is used throughout, extending it up into the side walls. An excavation across the ditch and a clay core puddled and tamped will be necessary to prevent seepage and settlement of earth under the structure. The notch in these structures (Fig. 6) varied from 30 by 5 inches to 36 by 6 inches as an increase in capacity was needed.

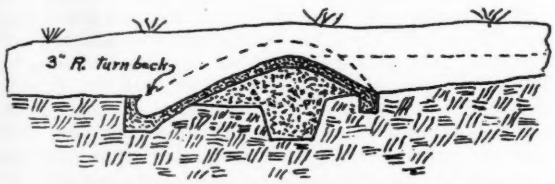



FIG. 5 SECTION VIEW OF CONCRETE ROAD DITCH CHECK

# Lakes in Rural Communities

By L. C. Tschudy

THIS PAPER deals with the water and soil conservation policies and problems in the northern portion of the Great Plains states. Here the wheat fields supply most of our nation's need for grain, and here the last of the grazing areas exist.

Small lakes are life to farming and grazing areas, especially during periods of drought. Many streams that have flowed the entire season now carry water only when the snow melts. The water conservation program is designed to collect and store a portion of this valuable flow and conserve it within the farm areas where it falls, rather than allowing the flow to continue on its course to the Hudson Bay in the north and the Gulf of Mexico in the south.

The past four years have been exceedingly hard on the farmers and ranchers in North Dakota, South Dakota, and Montana. The rainfall has been far below normal; crop failures have crept in to take their toll of an unusually large percentage of these areas; there has been a shortage of feed with grazing areas suffering; and this combined with water shortage for stock watering has brought destruction and disaster to wheat raising and stock grazing areas.

Does it seem possible that during the dry months the water table has been so reduced that ranchers must ship in water by rail to keep their stock alive? Does it seem possible that one small dam in a rural community could serve ten to fifteen farmers with no other water supply available? Does it seem possible that small inland towns are in danger of water famine? Does it seem possible that some small towns have no water for fire protection? These and many other questions, when answered with small dams to create lakes as a new source of life, will bring relief, protection, and *economic security* to farmers and ranchers in these areas.

This work brings both private and public benefits. When a rancher has a dam constructed by the government to create a lake, this is a private benefit to him. But it is also required that he share his advantage by donating from two to five acres of the land on the lake shore. Many cooperators have given as much as 40 acres so that the public might enjoy the lake. These areas are fenced off by a lane running to the road, in order that the public may utilize the water for stock or recreational purposes. This is only one of many community benefits.

Author: Engineer, Soil Conservation Service, U. S. Department of Agriculture. Mem. ASAE.

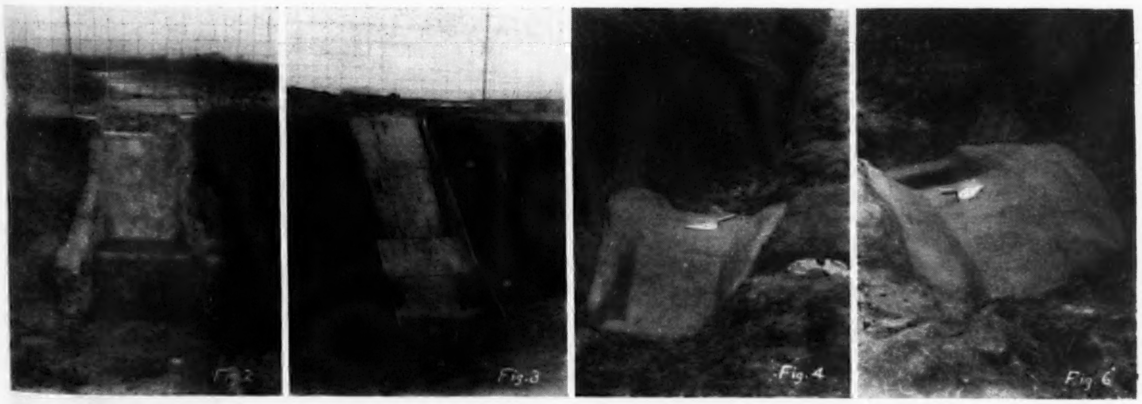



FIG. 2 FRONT VIEW OF TERRACE OUTLET WITH TURNBACK PLACED UP THE SLOPE. FIG. 3 A METAL OUTLET STRUCTURE. FIG. 4 AND FIG. 6 UP-STREAM AND DOWN-STREAM VIEWS, RESPECTIVELY, OF A THIN SECTION CONCRETE ROADSIDE DITCH CHECK

In this short space it would be difficult to elaborate on the benefits of lake developments in rural communities. This work has given a new lease on life to ranchers who have fought hard the last few years to survive. They no longer worry for fear that their cattle must be sold because there is no water to keep them alive. By damming the stream channel and by the flooding of bottom lands, they are confident of securing a hay crop.

A greatly increased acreage of hay and pasturage will be made possible by the water conservation resulting from the building of small dams.

In addition to meeting the immediate and pressing need of farmers for an ample and stable supply of feed and pasture, the effective conservation of water with which to insure crop growth affords the best possible means of preventing the recurrence of such disastrous wind erosion as recently resulted in the appalling losses of soils and crops in these drought-stricken areas of the Great Plains states. As insurance against such disasters in the future, the advantages of returning large areas of these wind-ravaged soils to grass will far outweigh the immediate benefits of replenishing the depleted supplies of hay and forage on farms of the Great Plains.

Nearly all the farmers near the lakes have reported more favorable water supply from their wells. Several dams have been located near town water supply wells so that the storage would filter through the strata to create a more constant supply for the communities.

### A SERIES OF SMALL DAMS IS LESS COSTLY AND MORE ADVANTAGEOUS THAN ONE LARGE DAM

Compare this picture with areas containing no dams where very often during the past few years winter grazing has been inadequate. Ranchers have been forced to sell far below cost of production or compelled to shoot the cattle. Their income gone, these men were forced to turn to relief. A small lake would have furnished sufficient water to provide an acreage sufficient to grow produce and some alfalfa. This security crop would have meant the difference between subsistence farming and direct relief.

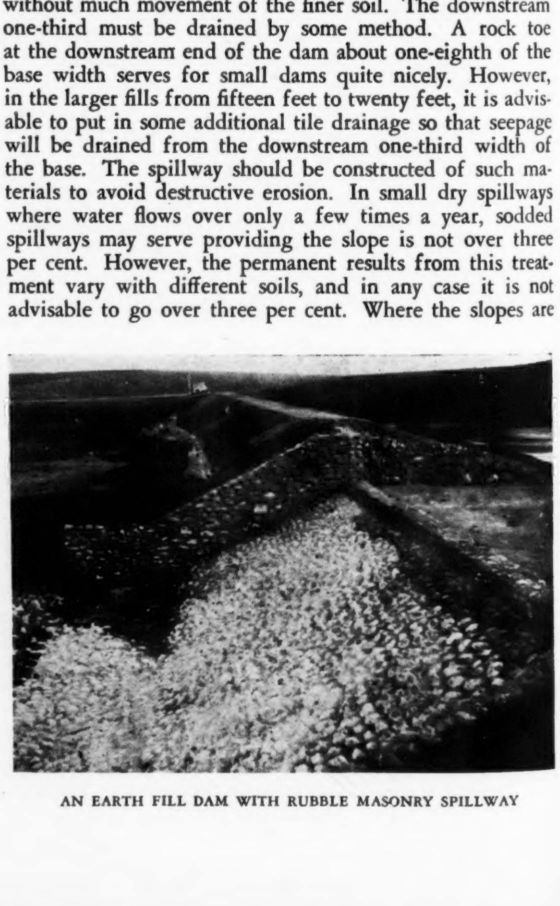
Numerous lakes could not be created if the dams were large. Twenty-five small dams can easily be constructed for the cost of a larger dam. For this reason the "small dam program" is more advantageous to the public, because it is receiving a maximum spread of benefit for the dollars expended. This program has been followed in North Dakota. The result is approximately 260 small dams scattered over the greater portion of the state. There are still many more surveyed and designed, but the policy has been to construct these where the most economical storage could be located. The definition of a small dam is "one established more or less by myself". The maximum height for earth fill is twenty feet, the maximum height for rubble masonry (gravity section) is ten feet, and the maximum height for timber crib (gravity section) is eight feet. It is quite possible by the small dam program to construct ten dams by one CCC camp in a six-months' period.

The CCC camps under the Soil Conservation Service located in these areas have been constructing small dams to create lakes in rural communities. Requests for the selection of these projects are investigated and approved by the supervising personnel in each camp under the direction of the regional personnel.

The request for each project is investigated thoroughly, the following points receiving particular attention: First, by the willingness of the cooperator, or cooperators, to have his or their lands inundated, and donate from two to five acres for public use. Second, the site must give indications of economical storage. Third, the foundation should be suitable for the construction of a dam. Fourth, the drainage area should be accurately determined for spillway designs. Fifth, available materials must be recorded to determine the designs to meet the topography. Sixth, the cost of the dam and acre-foot storage is estimated, and the unit acre-foot cost must be within economical limits or the project is not feasible. It is the policy to create a maximum of storage for each dollar expended.

The designs cover (1) non-overflow earth dams, (2) overflow rubble masonry gravity section dams, and (3) overflow timber crib gravity section dams.

The ideal design for small earthen dams consists of a cross section divided into one-thirds. The upstream two-thirds is of impervious materials with a core trench preferably in the center of the dam, and the downstream one-third is of more pervious material to allow drainage of seepage. The maximum height for this structure is twenty feet. The foundation should be stripped of all debris and the core trench should extend at least three feet through pervious and into impervious materials. The trench should be back filled and tamped with damp clay and some sand may be mixed into this clay material as this materially helps to bond the finer particles together. The earth fill should be carried up in three inches to six inches horizontal levels. Each layer should be sprinkled and rolled, preferably with a sheep's-foot roller, although tractors, trucks, and teams have the same effect, *if properly regulated.* This process should be carried to the top of the earth fill. The upstream face should be riprapped with approximately "man-size stones", preferably hand placed. Underneath this riprap the rock should be gradually graded from large to fine where the latter comes in contact with the impervious materials in the fill. This gradual grading from riprap to fine allows the waves to break against the large stones and drain beneath without much movement of the finer soil. The downstream one-third must be drained by some method. A rock toe at the downstream end of the dam about one-eighth of the base width serves for small dams quite nicely. However, in the larger fills from fifteen feet to twenty feet, it is advisable to put in some additional tile drainage so that seepage will be drained from the downstream one-third width of the base. The spillway should be constructed of such materials to avoid destructive erosion. In small dry spillways where water flows over only a few times a year, sodded spillways may serve providing the slope is not over three per cent. However, the permanent results from this treatment vary with different soils, and in any case it is not advisable to go over three per cent. Where the slopes are



AN EARTH FILL DAM WITH RUBBLE MASONRY SPILLWAY

A RUBBLE MASONRY, GRAVITY SECTION, OVERFLOW TYPE OF DAM

steeper and the flow large, or the flow continuous, permanent materials must be used. Rubble masonry serves this need economically where rock is available, and satisfactory results have been obtained from these designs. There must always be a safe freeboard, as overtopping of an earth dam is usually fatal.

The overflow rubble masonry gravity section dam is used in channels where the drainage area is very large and where there may be possible danger of eventual overtopping in the future. In these cases the stream channels are so flat that the backwater is almost as high as the headwater, and serious damage should not result when the dam is submerged. The maximum height is ten feet. The principle of constructing a good cut-off wall in these structures is very essential to the safety of the structure. The wing walls must run into the bank far enough to prevent washing around the end, and then when these points are located, extend them ten to twenty-five feet farther for a factor of safety. In rubble masonry, it is well to drain the apron to avoid heaving from freezing. The design of spillway capacity should always carry a liberal factor of safety. It must be remembered that a chain is no stronger than its weakest link. Each stone laid in mortar should be thoroughly cleaned, and once laid it should have a coating of mortar in all joints. The mortar should be from a 1:3 to 1:4 mix, and highway specification sand should be used. The face of the dam should not be plastered as this surface spawls as a result of frost action and represents poor economy.

Timber crib dams are used where it is difficult to excavate cut-off walls, or where there is a shortage of rock and gravel is used for a filler within the cribs. These structures, like rubble masonry, are used where the drainage area is large. They also have another advantage. This construction can be carried on safely during the winter months, when it is unsafe to mix mortar.

In this paper I have given a brief picture of the needs in rural communities for lakes where the grazing land covers thousands of acres, practically all of which are overgrazed. Overgrazed land blows, and soil losses increase with poor grazing land resulting. Dams spotted at needed places help to result in more efficient use of the grazing land. Dams spotted at regular intervals along stock trails help reduce shrinkage and save money for ranchers, as the lakes may be used as watering places for cattle driven miles over the trails to railroad centers.

Dams located in flat bottom land help to develop yearly alfalfa and wild hay supplies. Dams located near cities help to raise the water table and result in public benefit to communities.

A census of several counties in North Dakota shows that small lakes are excellent places for water fowl. North and South Dakota are no longer the large breeding grounds for water fowl, because so many of the natural lakes no longer exist. Our program is to restore natural conditions whenever and wherever possible. This means that every possible cultural and recreational factor is utilized by the people. Thousands of people visit these lakes to participate in bathing, picnicking, hunting and fishing.

History repeats itself! If the soil and water fail, the farmers and communities so affected cannot survive, they no longer are an asset but become a liability and a burden to economic society, and ultimately all society will suffer. They have the land, but they need re-education to save and utilize the soil and water to the best community advantage. The small dam program in rural communities furnishes that cooperative and moral support so necessary to bring new life to a depressed people.

# The Farm Pond

By W. H. McPheters

A FARM POND is made by damming a gully, ravine, and sometimes a small creek. The size of the pond varies considerably, depending on the topography of the land. Probably most ponds will vary in size from one-half acre to two acres, consisting of a drainage watershed of from ten to one hundred acres. However, there are times when a pond can be built that will cover several acres of land and take in a drainage watershed of some one hundred to three hundred acres and still be classed as a farm pond.

Ponds are generally filled by rain water from the watershed draining to the pond. However, there are many times when it is possible, where insufficient drainage area is available, to bring water from the opposite side of a hill by a heavy terrace, in order to fill the pond. Another method which occurs in seepy sections is to fill a pond from a spring or from terrace tile, or a hillside area. Ponds may also be filled from water that is drained from terraces. In this case, they are used primarily for the catching of terrace water. Of course, these conditions do not always exist, but advantage should be taken of them wherever possible.

Farm ponds may be divided into several types as follows:

1 The small pond formed along a terrace line by using an extremely heavy fill. This is simply a catch basin for silt and forms a pond for a short period of time only.

2 The type of pond that can be placed in a meadow or pasture to catch terrace water. This type may be used to hold water for only a short time. If it happens to be of considerable size and the water from the terrace goes over grass, this may serve as a good stock and fish pond. If the soil is a sandy type, it may be used as a dry pond merely to soak water into the ground to keep it from reaching the creeks.

3 Another type of farm pond is that built in a pasture to furnish stock water and used also for fishing.

4 Another type of farm pond may be used primarily for irrigation. It may be located outside of a pasture and convenient to a plot of ground to be irrigated.

The following are some of the more important uses of the farm pond:

1 The pond is certainly needed in the greater portion of the country for stock water. We have long dry spells in sections of the West, particularly where there is no other

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source of water for livestock, and the pond becomes almost a necessity. For this purpose, the pond should be deep. The size in area does not make much difference, but the depth determines whether or not it will hold water through long dry spells.

2 The pond as an erosion control method has been discussed in a preceding paragraph. It may be used along the terrace lines, probably using one or both ends of the terrace as a spillway to cut water off from a large ditch and spread it out on grass areas. Or the pond may be used in a field or in a pasture at the ends of terraces to collect the terrace water and soak it into the ground, thus keeping it out of the streams and lowlands below. Of course, a pond located anywhere helps keep some water out of streams.

3 Ponds may be made primarily for irrigation. In this case the pond is generally larger. It may be placed in a pasture where there is a field below it, or it may be placed directly in a field. In this case the field certainly should be terraced and the area around the pond grassed in order to keep it from filling up with sediment so quickly.

Irrigation for garden purposes should be practiced as much as possible by farm people, in order to make a living at home. Too often gardens give promise of an excellent crop, and then a dry spell comes. With the aid of a pond, these gardens could be saved. Many times the irrigation can be done by gravity, where the field is below the pond.

4 Another use of the pond, particularly in the West, is to furnish a place for tree growth. Trees may be planted around the pond, especially in the ravine below it, thus furnishing shady nooks for picnics or livestock. The pond itself furnishes a place for recreation in the way of fishing, boating, and swimming, and these things, although they may sound simple, have a bearing on the happiness and contentment of people on the farm.

### A POND MUST BE SIX FEET DEEP TO HOLD WATER THROUGH THE LONG DRY SPELLS

Many ponds in the past have been too shallow to hold water through the dry spells; therefore, at the time the water is most needed, there is none. The method of constructing the pond dam has not been understood by the farmer building it. He has simply thrown up a dam of dirt, not even removing the sod from underneath it, and the ponds have leaked. Also ponds have gone out due to improper size spillways. These failures have caused many farmers to say that it is impossible to have a pond. If water is to be kept over fairly long periods of time, a pond should always be at least six feet deep, and the dam should be built properly with a clay core to hold the water. These points will be discussed under different headings.

In choosing a location for a pond, select a place where it will be deep and cover considerable area, if possible. Depth is important if the pond is to retain water through long dry periods. Many times it is possible to find a narrow place in the ravine where a natural ridge forms the greater portion of the dam.

The purpose for which a pond is to be used should also have some bearing on its location. If used primarily for stock water and fish, the drainage from the barn should not be allowed to run into the pond. Many times this can be cut off by a terrace and turned onto the opposite slope. If used primarily for irrigation, of course, the barnyard drainage need not be considered.

A pond located so that the drainage area is a meadow or pasture is much preferred to a drainage from a cultivated field because it will not fill with silt so quickly. However, if the drainage area is a cultivated field, the field should be terraced and the area around the pond planted to grass; thickets of plums, blackberries, or other shrubs may be planted in the area above the pond. This causes the water to deposit the silt before entering the pond. The water from a meadow or terraced cultivated field is more likely to be clean than that from a pasture.

It is important to examine the subsoil to be sure that the pond will hold water. To do this, dig several holes to a considerable depth over the area, and particularly where the dam is to be built. A good tight clay subsoil is the best. If the subsoil is sand or gravel, the chances are the pond will not hold water. A clay or sandy loam can be made to hold, although there may be considerable seepage for a year or so. Should a pond be completed and the seepage happens to be more than expected, it is possible many times to check it by letting cattle or horses tramp the soil in the bottom and lower edge of the dam thoroughly while it is in a muddy condition. Clay hauled and spread over the muddy bottom while the tramping is being done will be of great help.

It would be fine, indeed, if the pond could be located exactly where one wished it, but unfortunately it is generally necessary to locate the pond in a ravine or small creek. Many times, therefore, it may be necessary to have the pond located somewhat inconveniently. However, the pond is generally much more valuable than the land it occupies, so that it is more important to have the pond, although somewhat inconveniently located, than to do without it.

### THE USE OF THE LEVEL IS ESSENTIAL TO DETERMINE THE DEPTH AND THE SIZE OF THE POND

Many times one's eye deceives him as to the size and depth of a pond that may be built in a given location, so it is necessary that a level be used to determine how deep and about how large the pond can be made before starting on the dam. Sometimes the slope of the land is so deceiving that one thinks he can build a large pond, but when the level is utilized, it is found that the pond will be very small.

It is also necessary to determine the approximate acres of land from which water drains to the pond, in order to determine the proper size of the spillway. A fairly large pond in a comparatively small drainage area is very desirable, that is, from four to six acres drainage for each acre-foot capacity of the pond. A small pond in a large drainage area will require a much larger and expensive spillway. These conditions are to be considered, but, after all, one has to build the pond for the existing conditions, even if they are not exactly what one desires, or if the cost is a little greater.

It is often necessary to use a level in making a preliminary survey of the pond site. If this preliminary survey shows that there is a likely pond site, then a final survey should be made. That survey should consist of laying out the line determining the water level of the pond, driving stakes every 50 or 100 feet, so that all brush may be cleared out of the area. After determining the depth of the pond, the other dimensions of the dam are obtained from Table 1. The number of acres in the watershed draining through the pond should be determined so that the proper size of spillway may be obtained. After this acreage is determined, the size of spill can be obtained from Table 2. Knowing the width of the dam at the bottom and the height and length of the dam, by use of Table 1, the yardage of earth may be figured which will be required to build the dam.

Clear the ground of all trash, brush, grass, and stumps the full width of the dam and plow this entire space so there is no possible chance for a seepage line. See that all gophers and moles are killed. Then take slips or fresnoes and remove the dirt from the middle of the dam, six or eight feet wide, down to firm clay, the full length of the

dam, across the draw and up both sides. This trench is to be filled in with damp clay, rather than top soil. The clay core should be carried to within a few feet of the top.

Before starting to build the dam it is advisable, but not necessary, to dig a trench from the deepest part of the pond across the dam site and lay a pipe so that a tank may be placed below the dam to furnish good pure stock water; also, this may serve to drain the pond occasionally in order to clean it. This pipe should be two inches in diameter for a small pond and three or four inches in diameter for large reservoirs. Rings of concrete should be put around the pipe every few feet so no seepage line will develop along the pipe. This is well worth the cost. Be sure this ditch is filled with clay and well packed around the pipe.

After this is done, begin moving the dirt. Take the first dirt from the bottom of the pond and start building the dam, always watching to see that clay is dumped near the middle of the dam. As the dam gets higher, dirt may be obtained from the sides so that the dirt will not have to be moved so far up hill. Build the dam in layers of not more than one foot in thickness, that is, one layer of dirt should cover the entire dam before starting a new layer. This insures the dirt being well packed, and it will settle evenly. Dirt can be moved more economically with a fresno than with a slip. Be sure that no porous material is put in the center or water side of the dam. Table 1 shows the safe width of dam for various heights.

The inner slope of the dam of a rather large pond should be riprapped with rock or paved with concrete to protect against wave action. The top and outer slope should be sodded with grass. The soil should contain some moisture while the dam is being built so that it will pack. Dry soil will not pack well.

TABLE 1. DIMENSIONS OF A DAM FOR A FARM POND

| *H* | *a* | *b* | *a* + *b* (*W*) | *w* | *d* | *i* | *o* |
|---|---|---|---|---|---|---|---|
| ft | ft | ft | ft | ft | ft | | |
| 5 | 12 | 7 | 19 | 4 | 3 | 2:1 | 1½:1 |
| 6 | 14 | 11 | 25 | 4 | 3 | | |
| 7 | 16 | 12.5 | 28.5 | 4 | 3 | | |
| 8 | 18 | 14 | 32 | 4 | 3 | | |
| 9 | 20 | 15.5 | 35.5 | 4 | 4 | | |
| 10 | 22 | 17 | 39 | 4 | 4 | | |
| 11 | 30.5 | 25 | 55.5 | 6 | 4 | 2½:1 | 2:1 |
| 12 | 33 | 27 | 60 | 6 | 4 | | |
| 13 | 35.5 | 29 | 64.5 | 6 | 4 | | |
| 14 | 38 | 31 | 69 | 6 | 4 | | |
| 15 | 48 | 33 | 81 | 6 | 5 | 3:1 | 2:1 |
| 16 | 51 | 35 | 86 | 6 | 5 | | |
| 17 | 54 | 37 | 91 | 6 | 5 | | |
| 18 | 58 | 40 | 98 | 8 | 5 | | |
| 19 | 61 | 42 | 103 | 8 | 5 | | |
| 20 | 64 | 44 | 108 | 8 | 5 | | |
| 21 | 67 | 46 | 113 | 8 | 5 | | |

*H*, height of dam
*a*, width from center to inner edge at bottom
*b*, width from center to outer edge at bottom
*a* + *b* = *W*, total width of dam at bottom
*w*, width of dam at top
*d*, distance from water level to top of dam, called the "free board"
*i*, inner slope
*o*, outer slope.

Slope of dam means ratio of horizontal distance to vertical distance. For example, assume a dam 15 feet high. From the table, $H = 15$ feet; $W$, the total width of the dam at the bottom = 81 feet. The inner slope is 3:1 and the outer slope 2:1.

Then the width of the dam at 1 foot height will be 3 feet less on the inner slope and 2 feet less on the outer slope. Therefore, the total width of the dam at 1 foot height will be $81 - (3+2) = 76$ feet. At 2 feet high the width will be $76 - (3+2) = 71$ feet. At 15 feet high, it will be $81 - 15\ (3+2) = 6$ feet.

The spillway must be large enough to carry all surplus water so that flood water will not overtop the dam. (See Table 2.) The free board, or the distance, *d*, that the dam should extend above the level of the spillway, can be obtained from Table 1. It should never be less than three feet. Where possible, place the spillway well to one side away from the dam. If the slopes are too steep, then place it at one end of the dam. Never put it on the dam unless the dam is built of concrete or masonry.

Where the dam is short and there is considerable flood water to be taken care of, it may be cheaper to build the dam of concrete. The masonry dam serves both as a dam and spillway. A masonry or concrete dam may be of the gravity type, or a heavy concrete wall with buttress on the lower side every few feet. An apron of concrete should be placed on the lower side of the dam for the water to fall on.

The protection of an earth spillway is very important. If it is not protected, the flood water flowing through it will cut it deeper with each rain, thus lowering the water level of the pond and endangering the dam.

THE CONSTRUCTION OF THE SPILLWAY TO PROTECT THE DAM DURING FLOOD IS HIGHLY IMPORTANT

Where the acreage draining to the pond is comparatively small, that is, not over six to ten acres for each acre-foot storage capacity of the pond, the spillway may be riprapped with loose rock or a series of level concrete curbs placed across it and the entire area sodded to grass.

The width of the grassed spillway should be one and a half to two times the width shown in Table 2. These curbs should be about a foot deep and need be only three or four inches thick. The top of the curbs should be level and just flush with the surface of the ground. They should extend squarely across the spillway. It may be necessary to take off some soil in places to make the flat ditch level so the curbs are flush with the surface. Of course, this flat ditch will have a fall. It is well to do the excavating before putting in the curbs and sodding with Bermuda or buffalo grass.

The curbs will be level, but each curb will be on a lower level than the one above. The steeper the slope, the nearer together the curbs should be. They should never be placed more than a vertical foot apart, and a difference of eight inches is preferable. It is also advisable to increase the width of this flat ditch as the slope gets greater so as to spread the water over a greater area. In order to get the grass started in parts of the ditch where all the topsoil has been removed, it may be wise to dig a narrow trench just below each curb and fill it with straw and good soil. Then sod with Bermuda grass and pin a strip of hog wire over the Bermuda sod to hold it in place until it gets firmly established. It is sometimes possible for a pond of small drainage area, to use a short, heavy terrace for a spillway and carry the water some distance from the pond to a naturally protected place to discharge the water.

Where a large quantity of water must pass through the spillway, it will be necessary to build the spillway of concrete or masonry. There are various ways of constructing the concrete spills. Sometimes the spillway may be made in the form of an inclined trough, but it is generally safer to make one or more vertical drops. The drops may be separated with level areas between them.

The ravine below the dam where the spillway discharges its water should be set to a dense growth of willows, black locust, blackberries, or some dense, heavy brush growth,

or dense growing grass, so that the ravine will not be cut deeper by the water coming over the spillway.

Table 2 shows the approximate width of the spillway in feet required for various areas drained into the pond. Figures given check fairly closely with the curves for rates of runoff from rolling cultivated land as found by C. E. Ramser.

A study of Table 2 shows that there is an increase of one foot in width of the spillway for every five acres of added drainage area. This increase continues up to 400 acres. Therefore, if desired, one may continue the table to 400 acres. Above 400 acres, the increase is at the rate of one foot width of the spillway for every ten acres added drainage area. All the above data is based on a maximum depth of two feet of water in the spillway.

Many times it may be difficult to get a spillway more than 30 to 40 feet wide. When this is the case, the spillway may have to be designed to carry a greater depth of water. A spillway carrying a depth of water just a little over three feet will take care of about twice as much water as a spillway of the same width only two feet deep. This means that a spillway carrying a depth of three feet of water will take care of practically twice the drainage area that a spillway of the same width but only two feet deep would take care of. It is better and safer, however, to make the spillway wide where possible rather than to require the depth of water to be greater.

Should the drainage area to the pond be much greater than 400 acres, it may be wise to call on the county agent for assistance. A spillway that is sodded to grass should always have a greater width than indicated by the table, if possible, in order to spread the water in as thin a sheet as possible.

### IT IS ALWAYS ADVISABLE TO FENCE IN THE POND TO KEEP ALL LIVESTOCK OUT

It is well to fence the pond so as to keep all livestock out. Stock wading out into a pond keep it roiled and filthy. The stock should drink from a tank placed below the dam and outside of the pond fence. This tank is filled from the pond by a pipe leading under the dam. The tank is kept filled by aid of a float valve. If this is provided, stock will always have good, clean water to drink. The water edge of the dam should be riprapped to prevent the waves from lapping the earth away. The top and lower side of the dam should be set to grass. The border or edge of the pond should be planted to grass. It is well to plant some shade trees around and below the pond. When the pond is new, it is well to watch it after each rain until it is filled and the dam is well settled.

Ponds that are full of water will not keep any water out of creeks and rivers during heavy rains. So a pond that will serve a farmer as a full pond, and at the same time serve as an empty pond to keep water out of the streams during heavy rains is the ideal pond.

This double-purpose pond can be made as follows: The pond may be laid out with a high and a low water level; that is, a pipe spill put in at the permanent or low water level, and a flood spill put in two or three feet above the pipe spill. The volume of water held temporarily between these two spillways is the flood capacity of the pond. This volume of water may be owned and controlled by the state and government in payment for aid given as help in the construction of the dam and spillway. This does not mean that the government should actually take possession of the pond, but that the government's portion of the water is held temporarily for a few days after each rain until it flows through the pipe spill, gradually feeding into the streams to prevent floods. Within a few days after each rain this portion of the pond is empty and ready

TABLE 2

| Drainage area, acres | Width of spillway, feet | Drainage area, acres | Width of spillway, feet |
|---|---|---|---|
| 1 to 3 | 3 | 101 to 105 | 25 |
| 4 to 6 | 5 | 106 to 110 | 26 |
| 7 to 10 | 6 | 111 to 115 | 27 |
| 11 to 15 | 7 | 116 to 120 | 28 |
| 16 to 20 | 8 | 121 to 125 | 29 |
| 21 to 25 | 9 | 126 to 130 | 30 |
| 26 to 30 | 10 | 131 to 135 | 31 |
| 31 to 35 | 11 | 136 to 140 | 32 |
| 36 to 40 | 12 | 141 to 145 | 33 |
| 41 to 45 | 13 | 146 to 150 | 34 |
| 46 to 50 | 14 | 151 to 155 | 35 |
| 51 to 55 | 15 | 156 to 160 | 36 |
| 56 to 60 | 16 | 161 to 165 | 37 |
| 61 to 65 | 17 | 166 to 170 | 38 |
| 66 to 70 | 18 | 171 to 175 | 39 |
| 71 to 75 | 19 | 176 to 180 | 40 |
| 76 to 80 | 20 | 181 to 185 | 41 |
| 81 to 85 | 21 | 186 to 190 | 42 |
| 86 to 90 | 22 | 191 to 195 | 43 |
| 91 to 95 | 23 | 196 to 200 | 44 |
| 96 to 100 | 24 | 201 to 205 | 45 |

to catch the next rain. All other rights and privileges of the pond belong to the owner. Of course the owner should be required by contract to keep the pipe spill open at all times.

Partly due to the drought of the last two years, there has been a great deal of interest in pond building, particularly for irrigation and stock water. To meet this interest, Extension Circular No. 175 of the Oklahoma A. and M. College has been prepared. Under a cooperative project of the extension service and the Rural Rehabilitation Corporation, a terracing and pond building project was started late in the spring. Through that project we have, in many counties, as many as 13 or 14 ponds built through this cooperative agreement. Farmers have paid for the cost of building the pond and are still demanding more ponds in these counties. The project was cut off, but the pond building program is still going on. Of course it is handicapped by lack of the supervision that was given in the project. We have in Oklahoma, another pond-building program, through the state conservation commission, cooperating with the WPA. There are limitations put on this program in the form of easement rights, which keeps it from going over as we would like it to do. However, this project is going to result in quite a number of good ponds over the state. Through the efforts of county agents, quite a number of ponds also have been built. Most of the ponds have been built for stock water and irrigation purposes. The Soil Conservation Service has built a few ponds in connection with the erosion control program. Through our FERA terracing and pond-building program, which lasted six weeks, we also got quite a number of ponds built.

This last year has been almost an ideal year for pond building, due to the dry spell and the government aid. The one great thing that I see from the starting of our pond-building program is that farmers have begun to realize that the dams must have more permanent bases than those of former small ponds.

When all the land in the country is terraced that needs to be terraced, and there is an average of one acre pond of the double-spill type on every 160 acre farm, we will have a good start toward reducing the flood menace so that people living on the bottom lands will be protected. The chances for hot winds will be less; there will be a better chance for shallow wells and springs; there will be more tree growth in the plains area; there will be less shortage of stock water. Good gardens will be possible on most farms in spite of dry weather. In fact, farm ponds on all farms where possible will enable the farmers to have a better living and the country at large will be benefited in many ways.

# The Division of Drainage (BAE, USDA)

*This is the fourth of a series of articles prepared by the USDA Bureau of Agricultural Engineering, dealing with the major divisions or activities of the Bureau; the other three articles appeared in* AGRICULTURAL ENGINEERING *for February, March, and April. The purpose of these articles is to acquaint the agricultural engineering field more thoroughly with the organization, functions, and activities of the Bureau. It is believed that the Bureau would welcome comments on these articles, as well as suggestions from the readers of this journal for improving the services of the Bureau in its particular field. We recommend that such comments and suggestions be addressed to the chief of the Bureau, Mr. S. H. McCrory, in Washington.*
*—Editor*

THE activities of the Division of Drainage, Bureau of Agricultural Engineering, U. S. Department of Agriculture, under Lewis A. Jones, are limited primarily to investigations relating to the drainage of agricultural land. The work is carried on from various field stations usually in cooperation with interested state agencies or local parties. A brief outline of the projects upon which work is being done at the present time follows.

## FLOW AROUND CHANNEL BENDS AND PIER NOSES

This project, under the direction of D. L. Yarnell, has been carried on in cooperation with the Hydraulic Laboratory of the University of Iowa for the past several years. The Bureau has issued two bulletins relating to the work, namely Technical Bulletin No. 429, "Pile Trestles as Channel Obstructions," and Technical Bulletin No. 442, "Bridge Piers as Channel Obstructions." These two bulletins present information which will enable designers to reduce in flood times the amount of backwater caused by such obstructions and hence shorten the length of time agricultural crops may be subject to overflow.

A report upon the "Flow of Water Around 180-Degree Bends" has been completed and submitted for publication. This report shows conditions of flow which may be expected in bends and is of value to engineers engaged in designing pumping plants and pipe layouts containing bends. Reducing losses in bends means greater capacities of pumps with no additional power consumption.

A report upon "Flow Around 6-inch Pipe Bends" has been completed and submitted to the University of Iowa for publication as a state bulletin. This report contains additional information of great value to designers of pumping plants for farm irrigation systems, and its use will aid in increasing plant efficiency with resulting lower cost of operation to agriculturists.

Plans have been completed to start an investigation of the action of the hydraulic pump on sloping aprons. Numerous lateral drainage ditches discharge through chutes or drops into main outlet ditches and similar structures are used in irrigation systems in lowering water from one elevation to another. With flood detention and water storage dams spillways are required to discharge excess water. In planning such structures insufficient attention is generally given to the dissipation of the energy in the water at the foot of the structure, and as a result failures are frequent through the serious erosion below the structure. The aim of the investigation is to determine the best methods of dissipating the energy of the swift water at the base of such structures and develop the cheapest and most efficient types of structures for solving this important problem.

## EFFECT OF SOIL ALKALINES, SOIL ACIDS AND FROST ON DRAIN TILE

In cooperation with the University of Minnesota, and the State Department of Conservation, an extended series of laboratory and field experiments relating to concrete-alkali and the effect of soil acids and frost on drain tile have been under way since 1920. D. G. Miller is in charge of the project with headquarters at University Farm, St. Paul, Minnesota. Under this project more than 30,000 samples of concrete of various types have been exposed to sulphate waters in Medicine Lake, South Dakota. A progress report was published as Technical Bulletin No. 358, "Laboratory and Field Tests of Concrete Exposed to the Action of Sulphate Waters." It has been determined that only cements above the average in resistance should be used in concrete to be installed where sulphates are present. Recent studies have devised a test routine for accurately determining the resistance of portland cement to attack by magnesium and sodium sulphates, the alkalies most common throughout the western states. It has been found that the most resistant standard portland cement will last up to ten times as long as cements of low resistance under identical conditions of exposure to these chemical compounds. It has also been determined that sulphate resistance of the concrete can be increased considerably by addition of calcium chloride in proper proportion when the concrete is being mixed, if followed by curing of the concrete in moist air at temperatures of 100 to 150 degrees (Fahrenheit). Curing at temperatures between 212 and 350 degrees without an admixture also greatly increases the resistance.

Studies relating to clay tile have made it possible to predict with some degree of accuracy, from standard absorption tests, the frost resistance of tile. This development has greatly simplified the testing of such tile and is having an effect in bringing about a general improvement in the quality of the clay tile sold in regions where tests have been made.

## GROUND WATER STUDIES IN THE PEAT AND MUCK LANDS OF FLORIDA

In cooperation with the Agricultural Experiment Station of the University of Florida, investigations are under way relating to the determination of the optimum depth of ground water for various crops in the peat and muck lands of Florida. B. S. Clayton has charge of the project with headquarters at the Everglades Experiment Station, Belle Glade, Florida.

Experimental plots have been established on which ground-water elevations are controlled at depths ranging from 6 to 48 inches. Several years' records will have to be obtained before reliable conclusions can be reached.

One of the most important problems connected with the development of peat soils is the rate of subsidence to be expected. The rate of subsidence is rapid when the land is first cultivated and decreases with time. The records of eleven subsidence lines which have been under observation for a period of years indicate that subsidence is almost entirely confined to that part of the peat deposit lying above the normal water table. This indicates that the water table should be held as high as is consistent with plant growth.

In a number of areas in Florida where the original depth of peat ranged from 7 to 10 feet, the total subsidence in the first 20 years following drainage has been approximately 5 feet. At the Everglades Experiment Station subsidence during the past 8 years on peat continuously in cultivation has averaged 0.12 foot per year. Rates at two other places have averaged somewhat higher.

Pumping records are being obtained at five drainage pumping plants serving muck and peat soils. The data so far available indicate that pumping plants serving peat areas in Florida growing truck crops should have a capacity sufficient to remove two or three inches of water per 24 hours from the area drained and that plants serving cane land should have a capacity of at least one inch per 24 hours.

Experience on the experimental plots indicates that mole drains are more effective and economical than tile drains in the peat soils of Florida. The drains, made by drawing a 6-inch bullet-nosed cylinder through the soil, should be placed about 15 feet apart and 2½ feet deep. The length should not exceed 600 feet.

## DRAINAGE OF SUGAR CANE LAND IN SOUTHERN LOUISIANA

At Houma, Louisiana, investigations are being carried on by E. G. Brown to determine the most advantageous depth and spacing of drains for sugar cane lands, and the effect of drainage upon the yield of cane and sugar. Experimental plots have been equipped with open drains ranging from 1½ to 6 feet in depth, and with tile drains ranging from 2 to 9 feet in depth, and pumps have been installed to handle the runoff. Sufficient data has not as yet been obtained to reach definite conclusions. To date either good surface drainage or underdrainage 2½ to 3 feet deep has given as good results as deeper drainage.

## IRRIGATION IN THE HUMID REGION

F. E. Staebner, with headquarters at Beltsville, Maryland, is in charge of this project. At the present time investigations are being carried on in cooperation with the Bureau of Plant Industry, the North Carolina State Department of Agriculture and the North Carolina Experiment Station, to determine the effect of different frequencies and amounts of irrigation on strawberries and raspberries. Experimental irrigation plots have been installed at Beltsville, Maryland, and at Willard, North Carolina, on which the effect of the time of irrigation upon yield, fruit-bud formation, etc., is being noted, and the effect of irrigation upon cultural practices such as topping strawberries, determined.

In order to reduce the cost of irrigation,

investigations are being continued at Beltsville on the development of portable types of spray irrigation systems with the view of reducing the first cost and making them adaptable to the man with a limited amount of labor available. Experiments have been conducted with pipe lines mounted on wheels and on sleds and connected with water supplies by flexible hose. Both systems have been found practical for irrigating low growing crops and mimeographed circulars have been issued outlining details of construction and limitations in use for such installations.

A limited number of experiments with clay sewer pipe lines with solid bituminous joints appear to indicate that it may be possible to use such pipe under considerably higher heads than have heretofore been deemed safe. Further experiments are required to check the results secured and to standardize the type of joint required. If clay sewer pipe can be safely used in some places where metal pipe are now considered necessary, the first cost of many irrigation systems can be materially reduced.

Experiments are being conducted aimed at the development of a gauge that will indicate the deficiency of moisture existing in a soil at any time, thereby showing when irrigation is required. Results obtained to date are promising.

The rapidly increasing use of porous canvas hose in irrigation has demonstrated the need for more reliable information as to the pressures under which such hose lines may properly operate and the rate at which they will deliver water to the crops. Extensive tests have been run on porous hose of various weights of material and with different treatments of the fibers in the canvas. The data when analysed is expected to show the proper weights of hose required for rolling ground, and the maximum lengths feasible for various weights of hose.

### RUNOFF INVESTIGATIONS

Due to shortage of funds under this project work is at present limited to two small watersheds in the vicinity of Iowa City, Iowa, being carried on by D. L. Yarnell, and to work on several watersheds in the peat and muck lands of Florida, conducted by B. S. Clayton. The results secured will be applicable to the areas represented by the watersheds upon which measurements are being made.

### SOIL WATER INVESTIGATIONS

In cooperation with the Minnesota Department of Conservation and the University of Minnesota, D. G. Miller is carrying on investigations in the swamp areas of northern Minnesota for the purpose of securing data from which to ascertain the extent to which drainage ditches have affected water storage capacities of certain swamps, and the effect of such ditches upon maintenance and stabilization of lake levels and stream flow. Several automatic gauges have been installed to determine groundwater elevations in drained and undrained swamps. Several years' records will be necessary before definite conclusions can be reached.

### EMERGENCY CONSERVATION WORK

The Division of Drainage is directing the work program of forty-six CCC camps working upon the maintenance of drainage improvements in organized drainage enterprises. These camps are located: two in Delaware; three in Maryland; nine in Ohio; eight in Indiana; two in Kentucky; six in Illinois; five in Iowa; six in Missouri; and five in Louisiana. The five camps in Delaware and Maryland are operated under the direction of R. W. Carpenter with headquarters at College Park, Maryland; the thirty-six camps in the six central states are under the direction of J. G. Sutton with headquarters at Milwaukee, Wisconsin; while the five in Louisiana are under the direction of B. O. Childs with headquarters at Alexandria, La.

The work of the camps consists principally of clearing and cleaning out ditches, clearing levees, relaying public tile drains, repairing drainage pumping plants and other structures owned by drainage districts. No work is done on privately-owned improvements.

In conducting the work the local drainage districts are, where practical, being required to furnish teams and tractors where needed; to purchase necessary materials; and to furnish excavating equipment if ditches too large for handwork are improved. By following this procedure the local people have a real financial interest in the work and the cost to the Government is limited primarily to supplying the labor of the camps. On April 1, 1936, cooperating drainage districts had made available to the camps more than 60 draglines, and several more offers were awaiting acceptance. Due to the temporary nature of the work, districts are being advised to rent machines from contractors rather than to purchase them.

The camps have purchased eighteen half-yard, diesel-powered draglines for work on small ditches. Where these Government-owned machines are operated the drainage districts are required to furnish oil and other supplies.

Under a cooperative arrangement with the Bureau, David H. Harker has been employed by the Director of Extension in Indiana to carry on drainage extension work in the area served by the drainage camps and to cooperate with the camp superintendents and county agents in the camp program. Herbert D. Fritz has been employed under similar arrangements by the Director of Extension in Illinois. The employment of these extension specialists is proving beneficial to the camp program.

# WHAT IS NEW
## *in Agricultural Engineering*

### FROM THE USDA BUREAU OF AGRICULTURAL ENGINEERING

DURING the month of February, as reported by J. G. Sutton, the 36 CCC camps in the Central District cleared a total of 7,695,819 square yards on drainage channels and levees, requiring 51,975 man-days. The excavation amounted to 202,583 cubic yards, requiring 2,254 man-days. A total of 515 man-days were spent on tile work. Emergency work and other items total 7,046 man-days.

Camp D-1, under H. C. Carstensen; D-2, under F. A. Daum; D-3, under W. A. Hogle; and D-9, under Clayton F. Kelley, were particularly active in emergency flood work in northwestern Ohio. The foremen blasted many ice jams in the rivers. Enrollees rescued many persons from flooded areas by means of boats and prevented much property damage.

Camp D-5, Havana, Ill., under Superintendent L. D. Putnam, prevented one levee break by having an organization on the job promptly after ice jams caused a rapid rise in a diversion channel. Camp D-5 also rendered valuable aid to a flooded district by blasting a hole in the levee at the lower end of the district, providing an immediate outlet for flood waters in the district and preventing the winter wheat from being killed.

### Contributions Invited

*It is not intended that the items published under the above heading shall be confined to new developments in the work of the USDA Bureau of Agricultural Engineering. The agricultural engineering departments of the land-grant institutions and other agencies of the federal government are cordially invited to contribute information on recent developments in agricultural engineering for which they may be responsible. It is desired that this feature of* AGRICULTURAL ENGINEERING *shall give as complete a thumb-nail sketch as possible of what is new in this field.*
—*Editor*

The Boyer River overtopped levees and completely inundated a large portion of Missouri Valley, Iowa. Enrollees of the camp there, under the direction of Superintendent F. R. Smith, rendered valuable service in removing persons and property from the flooded area. Camp D-2, Whiting, Iowa, under the direction of A. H. Mayne, is rendering valuable service during high water in the Missouri Valley lowlands.

* * *

The study under the direction of R. L. Parshall, of the deposition of silt in moving water at the silt laboratory near El Centro, California, was concluded in March. There were 21 tests where the discharge through the flume ranged from 7.5 to 99 second-feet. About 400 individual silt samples were obtained and the dry weight of solids for each sample determined, making possible the determination of the percentage by weight of the suspended load carried in the water at various depths of water flowing through the laboratory flume. The analysis of these silt samples was made by the USDI Bureau of Reclamation at the field testing laboratory of the All-American Canal, Yuma, Ariz. It is intended that hydrometric tests be made on each of the samples to determine the percentages of size of particle. At the conclusion of the work on the silt study, a modified form of the adjustable (Continued on page 221)

# PROGRAM

## 30th Annual Meeting of the American Society of Agricultural Engineers

### Stanley Hotel, Estes Park, Colorado—June 22 to 25, 1936

## SUNDAY, JUNE 21

2:00 to 8:00 p.m.—Registration, Stanley Hotel Lobby

7:00 to 10:00 p.m.—Council Meeting

## MONDAY, JUNE 22

8:30 a.m. to 12:30 p.m.—(Three concurrent sessions)

### I — COLLEGE DIVISION

Presiding: *R. H. Driftmier*, division chairman

1 "Preparation and Presentation of Agricultural Engineering Extension Subject Matter"—*J. P. Fairbank*, University of California.

2 "Subject Matter and Objectives in Teaching Dairy Engineering"—*A. W. Farrall*, Creamery Package Mfg. Co.

3 "Status of Agricultural Engineering Research in the Land-Grant Institutions"—*R. W. Trullinger*, USDA Office of Experiment Stations

4 "Agricultural Engineering Teaching Methods in a Junior College"—*H. D. White*, Abraham Baldwin Agricultural College

5 Committee Reports

### II — COMMITTEE ON EXTENSION

Presiding: *H. H. Sunderlin*, committee chairman

### III — STUDENT GROUP

Presiding: *Paul Doll*, president, National Council of ASAE Student Branches

1 "The Agricultural Engineer in Extension Work—*L. F. Livingston*, E. I. du Pont de Nemours & Co.

2 "The Agricultural Engineer in the Commercial Field"—*Leonard J. Fletcher*, Caterpillar Tractor Co.

3 "The Agricultural Engineer in College Instruction"—*M. M. Jones*, University of Missouri

4 "The Agricultural Engineer in Research"—*E. G. McKibben*, Iowa State College

2:00 to 5:00 p.m.—Committee and group conferences, trips, etc.

8:00 to 10:00 p.m.—Illustrated lecture on Rocky Mountain National Park

## TUESDAY, JUNE 23

### 8:30 to 10:30 a.m.—GENERAL SESSION

Presiding, *L. F. Livingston*, President

1 Meeting opened—*E. M. Mervine*, chairman, Local Committee

2 Address of Welcome—*Dr. Chas. A. Lory*, president, Colorado State College

3 President's Annual Address: "Agricultural Engineering Marches On"—*Lawrence F. Livingston*, manager, agricultural extension section, E. I. du Pont de Nemours & Co.

4 ADDRESS: "The Common Interests of Agriculture and Industry"—Ralph E. Flanders, president, Jones and Lamson Machine Co.

10:30 a.m. to 12:30 p.m.—(Two concurrent joint sessions

### I — POWER AND MACHINERY DIVISION AND SOIL AND WATER CONSERVATION DIVISION

Presiding: *Frank. J. Zink* and *Virgil Overholt*, respective division chairmen

SYMPOSIUM: "Correlation of Terrace Construction Practice and Farm Machine Design"

1 "The General Problem of Operating Farm Machinery Over Terraced Fields and Hillsides"—*R. W. Baird*, USDA Soil Conservation Service

2 "Factors in the Development of Terrace Sections"—*W. D. Ellison*, USDA Soil Conservation Service

3 "Farmers' Methods of Machinery Conversion to Operate Grain Machinery over Terraced Fields and Hillsides"—*C. A. Logan*, USDA Soil Conservation Service

4 "The Operation of Row-Crop Equipment over Terraced Fields and Hillsides with Special Reference to Corn Machinery"—*C. K. Shedd*, USDA Bureau of Agricultural Engineering

5 "Design of Tillage Machines to Meet Requirements of Terraced Fields and Hillsides"—*R. J. Altgelt*, Oliver Farm Equipment Co.

### II — FARM STRUCTURES DIVISION AND RURAL ELECTRIC DIVISION

Presiding: *K. J. T. Ekblaw* and *I. P. Blauser*, respective division chairmen

1 "Farm Lighting Recommendations"—*L. C. Porter*, General Electric Co.

2 "Dairy Barn Ventilation"—*J. H. McCabe*, American Blower Corp.

3 "The Farm Wiring Problem"—*H. G. Knoderer*, General Electric Co.

4 "The Agricultural Engineers' Interest in Resettlement Project Homes"—*R. H. Driftmier*, University of Georgia

5 "Homes for Texas Farmers"—*Dan Scoates*, Resettlement Administration

6 "Sanitation in Resettlement Homes"—*R. M. Dixon*, Resettlement Administration

2:00 to 4:00 p.m.—Committee and group conferences, trips, etc.

4:00 to 5:00 p.m.—Annual Business Meeting

8:00 to 10:00 p.m.—Illustrated Lectures

## WEDNESDAY, JUNE 24

### 8:30 to 10:30 a.m.—GENERAL SESSION

Presiding: *L. F. Livingston*, president

1 "What Hath Agricultural Engineering Wrought?"—*Wheeler McMillen*, editor, "The Country Home"

2 "Looking Ahead in Agricultural Engineering"—*H. B. Walker*, professor of agricultural engineering, University of California

**10:30 a.m. to 12:30 p.m.**—(Four concurrent sessions)

### I—POWER AND MACHINERY DIVISION

Presiding: *Frank. J. Zink*, division chairman

1 "Control of Weeds by Sulphuric Acid Sprays"—*O. C. French*, California Agricultural Experiment Station

2 "New Developments in Sugar Beet Machinery"—*E. M. Mervine* and *S. W. McBirney*, USDA Bureau of Agricultural Engineering

3 "Natural Drying of Farm Products"—*T. N. Jones*, Mississippi State College

4 "Recent Developments in Pneumatic Tires and Wheel Equipment for Farm Machines"—*J. W. Shields*, Firestone Tire and Rubber Co.

### II—RURAL ELECTRIC DIVISION

Presiding: *I. P. Blauser*, division chairman

1 "Cooperation in the Extension of Electric Service to Farms"—*D. S. Weaver*, USDA Extension Service and Bureau of Agricultural Engineering

2 "Development of Electric Business in Rural Territories"—*J. C. Scott*, Puget Sound Power and Light Co.

### III—FARM STRUCTURES DIVISION

Presiding: *K. J. T. Ekblaw*, division chairman

1 SYMPOSIUM: "Farm Storage of Grain"

(a) "Progress Report of Wheat Storage Project"—*Wallace Ashby*, USDA Bureau of Agricultural Engineering

(b) "Grain Storage in California"—*J. D. Long*, University of California.

2 "Does Painting Farm Buildings Pay"—*Don Critchfield*, Lead Industries Assn.

### IV—SOIL AND WATER CONSERVATION DIVISION

Presiding: *Virgil Overholt*, division chairman

1 "Drainage Activities"—*L. A. Jones*, USDA Bureau of Agricultural Engineering

(a) "State Drainage Laws with Reference to Maintenance"—*J. H. Neal*, University of Minnesota

(b) "Methods of Maintaing Public Drainage Improvements"—*E. W. Lehmann*, University of Illinois

(c) "Benefits and Accomplishments of Drainage"—*J. G. Sutton*, USDA Bureau of Agricultural Engineering

2 "Improving Drain Tile Resistance to Alkali Conditions"—*Dalton G. Miller*, USDA Bureau of Agricultural Engineering

3 "The Ohio Watershed and Hydrologic Studies"—*C. E. Ramser*, USDA Soil Conservation Service

**2:00 to 5:00 p.m.**—Committee and group conferences, trips, etc.

**6:30 to 9:00 p.m.**—ANNUAL ASAE DINNER

## THURSDAY, JUNE 25

**9:00 a.m. to 12:00 a.m.**—(Four concurrent sessions)

### I—POWER AND MACHINERY DIVISION

Presiding: *O. E. Eggen*, division vice-chairman

1 "New Developments in Fertilizer Placement Research"—*G. A. Cumings*, USDA Bureau of Agricultural Engineering

2 "Engineering Phases of Pink Bollworm Control"—*D. A. Isler*, USDA Bureau of Agricultural Engineering

3 "Statistical Methods in Agricultural Engineering Research"—*A. E. Brandt*, Iowa State College

4 "Effect of Particle Size of Dusts in the Testing of Internal-Combustion Engine Air Cleaners"—*F. A. Brooks*, University of California

(a) *Fred R. Nohavec*, engineer, Donaldson Co.

5 "Developments in Offset Disk Harrows"—*O. W. Sjogren*, Killefer Mfg. Co.

6 "Proposed Tractor Drawbar Standards"—*D. A. Milligan*, Cleveland Tractor Co.

7 "Problems in Farm Operation of Diesel Engines"—*A. H. Powell*, Utah State Agricultural College

8 "Tractor Engine Lubricatión under Low-Temperature Conditions"—*E. A. Hardy*, University of Saskatchewan

9 Reports of Committees

### II—RURAL ELECTRIC DIVISION

Presiding: *Geo. A. Rietz*, division vice-chairman

1 "Precooling of Fruit"—*T. E. Hienton*, Purdue University

2 "Present Status of the Electric Fence"—*G. W. Kable*, Tennessee Valley Authority

3 "Selection of Electric Motors and Their Controls for Agricultural Uses"—*B. P. Hess*, Westinghouse Electric and Mfg. Co.

4 Reports of Committees

### III—FARM STRUCTURES DIVISION

Presiding: *A. M. Goodman*, division vice-chairman

1 "Adobe Construction"—(Speaker to be selected)

(a) *J. D. Long*, University of California

2 "Farm Building Costs and Appraisals"—*G. B. Hanson*, Resettlement Administration

3 "Farm Building Valuation as Related to Long Term Loans"—*A. E. Bachman*, Federal Land Bank of California

4 "Valuations of Farm Improvements"—*E. W. Lehmann*, University of Illinois

5 "Inspection and Appraisal of Farm Buildings for Insurance Purposes"—*E. D. Anderson*, Farmers' Mutual Re-Insurance Assn.

6 Reports of Committees

### IV—SOIL AND WATER CONSERVATION DIVISION

Presiding: *C. E. Ramser*, division vice-chairman

1 "Planning the Use of Irrigation Resources"—*Frank Adams*, University of California

2 "Problems Peculiar to Irrigation Farming—*O. W. Israelsen*, Utah State Agricultural College

3 "Engineering Problems in Erosion Control in California and Nevada"—*J. G. Bamsburger*, USDA Soil Conservation Service

4 "Soil Conservation Problems in Colorado"—*A. E. McClymonds*, USDA Soil Conservation Service

5 "Soil Erosion Control in the Tennessee Valley"—*J. H. Nicholson*, Tennessee Valley Authority

6 "Soil Moisture Conservation"—*Raymond R. Drake*, USDA Soil Conservation Service

7 "New Developments in Terracing in the Southeast"—*M. L. Nichols*, USDA Soil Conservation Service

8 Reports of Committees

# NEWS

## Second Dearborn Conference of Agriculture, Industry and Science

L. F. LIVINGSTON, president of the American Society of Agricultural Engineers, and manager of the agricultural extension section of E. I. du Pont de Nemours and Company; Wheeler McMillen, editor, "The Country Home"; and Harper Sibley, manager of Sibley Farms and president of the Chamber of Commerce of the United States, are the ASAE members who will officially participate in the Second Dearborn Conference of Agriculture, Industry, and Science, called for May 12, 13, and 14 at Dearborn, Michigan, under the joint sponsorship of Farm Chemurgic Council and The Chemical Foundation.

President Livingston will address the Conference on "Chemurgic Progress in the Land-Grant Colleges," opening the insecticides and fertilizers session on the morning of May 14. Mr. McMillen, who is Farm Chemurgic Council's vice-president for agriculture, will preside over the opening general session on Tuesday morning, May 12; the closing general session on Thursday afternoon, May 14; and the business session, Thursday evening. He will also address the banquet Wednesday evening, May 13, on "The Philosophy of Chemurgy." Mr. Sibley will discuss the subjects of the opening general session following their presentation.

Many other leaders in agriculture, chemistry, and engineering will participate in the Conference. The sponsors define its purpose as "To advance the industrial use of American farm products through applied science.

Subjects slated for the opening session are "Science in Industry," "Economic Importance of Scientific Education," "Research with Terminal Facilities," "Industry's Stake in Farm Prosperity," and "A Chemist Looks at the Farm Problem."

In a "Symposium on New Things" subjects scheduled are "American Beverages and the Surplus Fruit Problem," "Cork Oak Trees for the Next Generation," "Organo-Phosphates as Potential Fertilizers," "Pyrethrum—a New Crop," "Tung Oil," "Perilla and Other New Oil Crops," and "Cotton Roads."

One-half day will be devoted to "Power Alcohol," with addresses on "The Relation of Power Alcohol to Our Economic Problems," "America's First Power Alcohol Plant," "Jerusalem Artichokes," "Coming Motor Fuels," and "Our Domestic Petroleum Supply."

Sectional meetings will feature starch and sugars, plastics, cellulose, soybeans, and insecticides and fertilizers.

## Election to College Group

IN THE election of two members to serve two years each as members of the Advisory Committee of the College Division of the American Society of Agricultural Engineers, F. R. Jones, professor of agricultural engineering, A. & M. College of Texas, and B. B. Robb, professor of agricultural engineering, Cornell University, were elected to the Committee and will begin their terms following the annual meeting of the Society in June. Other members of the Committee for the ensuing year are E. G. McKibben, associate professor of agricultural engineering, Iowa State College, and C. O. Reed, professor of agricultural engineering, Ohio State University. The chairman of the Committee and of the College Division for the coming year will be Hobart Beresford, professor of agricultural engineering, University of Idaho, Moscow.

## Local Sections Organized

AT A dinner of about 50 agricultural engineers held in Washington, D. C., on April 28, it was voted to organize the agricultural engineers in Washington and vicinity and petition the Council of the American Society of Agricultural Engineers for official recognition as the "Washington Section" of the Society.

The presiding officer at the dinner appointed a nominating committee, which submitted nominations for officers of the proposed section who were unanimously elected, as follows: Chairman, S. H. McCrory, chief, USDA Bureau of Agricultural Engineering; vice-chairman, R. W. Trullinger, principal agricultural engineer, USDA Office of Experiment Stations, and secretary, W. M. Hurst, USDA Bureau of Agricultural Engineering.

This is the second of local groups to petition the ASAE Council for recognition as a section of the Society, the first being the agricultural engineers of Oklahoma who are organizing the "Oklahoma Section," with the following officers: Chairman, Roy E. Hayman, in charge of rural electrification, Oklahoma Gas & Electric Co.; vice-chairman, L. E. Hazen, head, agricultural engineering department, Oklahoma A. & M. College, and secretary, C. V. Phagan, assistant extension agricultural engineer, Oklahoma A. & M. College.

There appears to be considerable interest in the organization of local sections of the ASAE confined to state lines, and other state groups of agricultural engineers are considering similar action. The organization of state sections is in harmony with the constitution and by-laws of the Society.

## Washington News-Letter

*from* AMERICAN ENGINEERING COUNCIL

IT IS "open season" in Washington for speculation regarding future relief, work relief and emergency spending programs. Buchanan, Glass, and the President are generally conceded to sincerely desire economy and are credited with the intention to stay within budget estimates, but they allow Congress to compromise. Members of Congress talk economy and tremble over the thoughts of inflation and heavy increases in taxes, but yield to reelection temptations and the use of borrowed money.

Just when Congress was gaining strength to resist persuasion from the heads of the emergency agencies and callous political subdivisions for the continuation of huge appropriations for loose spending almost unprecedented storms and floods struck enough of the eastern states to weaken or eliminate the resistance. Some of the more threatening investigations of the activities of emergency agencies are about to be abandoned, and hearings involving more billions are crowding economy ideas and new schemes of taxation for attention.

With support of actual unexpected needs arising in the newly stricken areas and the emotional reactions from other parts of the country, it begins to look as if the Public Works Administration may get $750,000,000 to complete its commitments and $1,500,000,000 might be appropriated for the continuation of other emergency activities.

Congress has not confined its generosity to relief and emergency appropriations. It is weakening under pressure to increase the appropriations for the regular departments, and extras are accumulating in pending deficiency measures. So, despite economic improvement and good intentions, expenses are rising faster than revenues, and the outlook for the next fiscal year is as much as two billion dollars out of balance.

We continue to see evidences of a behind-the-scenes trend toward balancing the budget, but its realization now looks to be several years away. Campaign year commitments are likely to carry federal government financing of spending well into 1937 and lead to further inflation of the credit base. Conditions are improving, rapidly enough however, to prevent any collapse of government credit within the visible future.

Sentiment "on the Hill" is decidedly favorable to the public works type of spending with a policy similar to the present grant and 4 per cent loan basis, but members of Congress do not support it exclusively, because it has not been made applicable to the smaller communities and because of personal differences with Secretary Ickes. They want to discourage undertakings like the Florida Canal and Quoddy, but will vote to continue to completion the average project already under construction.

Hopkins can not hope to escape more charges of inefficiency, waste, and the indirect use of relief funds for political purposes, but the "breaks" of distress are with him and criticism only emphasizes the fact that he has attained the goal for the distribution of funds on a work relief basis where others have failed to provide the expected employment for the heads of relief families. In many instances he admits mistakes as he proves that he got "the spending job" done. He is still strong with the Administration.

No changes in policies have been announced by the Procurement Division of the Treasury. They have committed them-

selves to the limit of their appropriations and are furloughing designing engineers and architects until they know what funds are to be made available. Their program is comparatively free of criticism here and observers agree that it is likely to be continued.

A large portion of the new appropriations is likely to go to reclamation under pressure from the West and western members of Congress. Little criticism of reclamation work is heard in Washington and where the projects mesh in with soil erosion, conservation, and land utilization, the comment is favorable. The momentum from the able leadership of Dr. Mead carries its activities on in expectation that another strong engineer executive will continue the constructive policies.

The sound economical purposes of the current agitation for the reorganization and consolidation of departments and agencies of the federal government are confused with political strategy. The studies are scheduled to be made by the Brookings Institution under the direction of Senator Byrd's committee, headed by Dr. Louis Brownlow of Chicago, but the leaders of the movement admit its lack of organization and are admittedly doubtful about its success.

Council has placed the recommendations of its committees and its files of valuable factual information regarding the increases in efficiency and economies that might result from reorganization and consolidation of kindred government agencies at the disposal of Senator Byrd's committee and the Brookings Institution. We have discussed the situation with those in charge and made them understand that Council is sympathetic and anxious to be of service. So much of what could be done, however, depends upon political pressure and the organization of the work of the Committee is proceeding so haltingly that no action is expected until after the election.

The staff has been in close contact with Major George L. Berry's Council for Industrial Cooperation. It was supposed to have been organized at the request of the President to develop a closer understanding between government, labor, and industry, and an acceptable application of some of the better phases of the "late" National Recovery Administration. It was believed by some to be an unbiased group of committees, with a small administrative organization, until Berry announced the formation of a "non-partisan labor league" to work for the re-election of Roosevelt. That announcement followed an executive order creating two new units out of the NRA skeleton, the Committee of Industrial Analysis and a Council of Industrial Progress. Both appear to be aimed at new legislation governing wages and hours in the next session of Congress.

On its face, this seems like a strange conclusion to the efforts of several committees of serious-minded business men, one of which was invited to determine the effects of government spending and competition upon private enterprise. It was officially rumored in that connection that the President was anxious to have practical recommendations for at least a partial elimination of government competition. In any event, $40,000.00 of the Emergency Relief Appropriation of 1935 has been reserved for the continuation of Coordinator Berry's activities.

We are happy to announce receipt of an application for membership from the New York Electrical Society which was founded in 1881. They have over six hundred members and we are sure that their coming in the spirit of unity will add to Council's prestige.

Almost every engineer invited to serve on Council's committees has accepted and some committees are becoming active. The new program will be formally inaugurated by the Executive Committee at its meeting in Washington during the last week in April and presented as cases for consideration to the several committees. That will include the new State Public Affairs Contact Committee, which is being created to stimulate an increasing interest in public affairs through the promotion and support of state and local public affairs committees and to serve as a clearing house, in both directions, for sound ideas and factual information along engineering and economical lines.

## Personals of ASAE Members

*W. C. Krueger,* extension agricultural engineer, New Jersey State College of Agriculture, is author of Extension Bulletin 171, entitled "Electric Hotbeds," recently issued by that institution.

*Gail M. Redfield,* research assistant in home economics, and *Truman E. Hienton,* agricultural engineer, Purdue University, are joint authors of Circular No. 214, entitled "Electrically Served Farm Household," recently issued by that institution.

*J. P. Schaenzer* has been appointed assistant director of the Committee on the Relation of Electricity to Agriculture. Following an extended experience in vocational agriculture work, he was for five years project director of rural electrification work in Wisconsin, and later became agricultural and irrigation engineer with the Federal Power Commission. For the past three months he has been chief of the electrical installation, architectural, and engineering planning section of the Resettlement Administration. After June 1 he will be located at CREA headquarters in Chicago.

*D. E. Wiant,* instructor in farm machinery and power, South Dakota State College, and L. W. Minium, formerly a member of the agricultural engineering staff of that institution, and now assistant agricultural engineer, USDA Soil Conservation Service, are joint authors of Bulletin 297, entitled "Hitches for Field Machinery," recently issued by that institution.

## Necrology

FRANK R. BROWNLEE, general superintendent of the Hopkins Plant of the Minneapolis-Moline Power Implement Company and member of ASAE since 1935, passed away March 7, 1936.

Born in Milwaukee, Wisconsin, in 1883, he graduated from its public schools and in 1908 was graduated from the University of Wisconsin with the degree of bachelor of science in mechanical engineering. Employment with the Minneapolis Steel and Machinery Company in 1918 as designer introduced him to the farm equipment field. His first work with that company was on its "Twin-City" thresher. He advanced rapidly and when his company consolidated with others to form the Minneapolis-Moline Power Implement Company he was placed in charge of its thresher plant at Hopkins, Minnesota.

He is survived by his wife, one son and one daughter.

## Former ASAE Member Passes Away

VERNE W. STAMBAUGH, former member of the American Society of Agricultural Engineers, passed away suddenly April 20 at the Larimer County Hospital, Fort Collins, Colorado, following an operation there several days previously. He was employed as research engineer in the USDA Soil Conservation Service and was working in its headquarters at Colorado Springs.

Mr. Stambaugh was a graduate of Kansas State College. He is survived by his wife, his mother, Mrs. Johanna Stambaugh, of St. Mary's Kansas, two brothers, Emmett and Harman Stambaugh, also of St. Mary's.

## Applicants for Membership

**The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the April issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.**

*Thomas L. Baggette,* junior agricultural engineer, U. S. Cotton Ginning Laboratory, Stoneville, Miss.

*L. C. Watson,* technical foreman and camp engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Camp Green, SCS-28, Xenia, Ohio.

*Emerson Wolfe,* assistant agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) McGregor, Iowa.

TRANSFER OF GRADE

*B. Parker Hess,* rural electrification department, Westinghouse Electric and Manufacturing Company, Room 6-N-47, East Pittsburgh, Pa. (From Junior to Member)

## Texas Student Branch News

THE Texas A. & M. College Student Branch is carrying on a very active schedule during the second semester of this year and more interest is being shown in the Society than ever before.

On January 17 the Branch honored L. J. Fletcher, manager of agricultural sales of the Caterpillar Tractor Company and L. C. Fuller, Texas sales representative, with a banquet. Mr. Fletcher made a very interesting talk on "The College Graduate and Industry." In this talk he explained how industry feels toward the college graduate and stated some of the desirable characteristics of these men who expect to go into industrial work.

At a regular meeting on February 18 an election was held at which W. F. Appelt was elected vice-president of the Branch to fill the vacancy left by the graduation of J. F. Roberts. At the same meeting, F. R. Jones gave a discussion of the requirements and prizes for a contest sponsored by the local agricultural engineering department. This contest has started some keen competition among the students and everyone is working hard to win.

On March 7 the Branch held its annual "Barnyard Frolic" in the agricultural engineering building. The building was decorated in typical barnyard fashion, bales of hay were used in place of chairs and different types of farm machines were placed

around the edge of the dance floor. Two hundred and fifty couples attended, taxing the capacity of the third floor of the building. Prizes were awarded for the best barnyard costumes.

At the meeting on March 19 plans were made for the "Annual Engineering Show" to be held on May 9. Committees on land reclamation, farm machinery, farm power, farm building, farm home conveniences, and farm shop were appointed. The branch plans to have an exhibit on every phase of agricultural engineering. An automobile show of all late model cars by local dealers will also be included.

Twelve seniors of the department went on an inspection trip from April 11 to 15. They inspected the soil conservation project at Lockhart, Texas, and irrigation projects, industrial plants and others things of interest in and around San Antonio and Austin, Texas.—C. B. Lyle, Jr., scribe

## Idaho Student Branch News

THE Idaho Student Branch has just completed an interesting and worthwhile field trip. It took us to Corvallis, Oregon, by the way of Portland, along the coast for a few hundred miles, and back to Moscow. On April 10 and 11 we were the guests of the Oregon Student Branch where some interesting meetings and luncheons were held by the two groups. Some of the projects that were inspected by the Idaho group on the trip were Bonneville Dam, power plants, distilleries, and bridges such as the Yaquina Bay bridge which is now under construction. This bridge is magnificent. The main concrete arch over the ship channel will be 500 feet long.

The branch members have been busy preparing for the biennial Engineers' Show and Little International given on May 2. A parade was also held the same day. Many new engineering feats were demonstrated at this show. A few of the numerous displays were: alcohol-gas blend demonstrations, mysterious and talking robots, alcohol production from waste farm products, new applications in rural electrification, and many engineering applications for the farm.

The Idaho group was honored last month by Mr. H. E. Barnard, director of research for the Chemurgic Council. He gave a very interesting talk explaining the Chemurgic Council, and the future possibilities of waste farm products.—Wilson Bow, scribe

## Virginia Student Branch News

AT THE meeting on March 26, the beginning of a new quarter, there was a short program. The main business was the planning of the program for the quarter.

On April 6, interesting talks on "The Future of Agricultural Engineering" and "Curing Tobacco," were given by two student members.

The Caterpillar Tractor Company furnished four interesting and instructive reels showing the manufacture, operation and economy of Caterpillar tractors and engines, for our meeting on April 9. Emphasis was placed on diesel-powered equipment.

On April 16, V. R. Hillman, former professor and faculty adviser at V. P. I., and F. P. Trent, agricultural engineering graduate of V. P. I., were with us. Mr. Hillman and Mr. Trent now work with the Virginia Soil Conservation Service as chief agricultural engineer and assistant agricultural engineer, respectively. Mr. Hillman gave a lecture relative to Soil Conservation Service through the state. His lecture was illustrated by maps, charts, and aerial photographs. Mr. Trent told the members of some of his experiences since graduating from here.—A. M. Brown, scribe

## Iowa State Branch News

ON THE night of March 26, the first day of the spring quarter, Leonard J. Fletcher, agricultural sales manager of the Caterpillar Tractor Company, gave an interesting talk to the Student Branch of ASAE at Iowa State College. The subject of his talk was "The Agricultural Engineer and His Responsibilities in the Field." We are always glad to have men like Mr. Fletcher spend a few hours with us when in our section of the country, and hope that he and others may favor us with an early return visit.

A special business meeting of the Branch was called April 9 for the purpose of electing officers and cabinet members for the coming fiscal year. Orville Fox, a junior, was elected president to succeed William McConnell, who has led us the past three quarters. Other officers are: Vice-president, Richard Frevert; secretary, George Dunkelberg; treasurer, Charles Thomas.

Representatives to the Engineering Council will be: senior, Lawrence Skromme; junior, Harold Hanson. Places on the Agricultural Council will be filled by Donald Malcolm, senior representative, and Harold Thompson, junior representative.

Eleven members of the Branch returned April 15 from a three-day inspection tour to Peoria, Moline, and Rock Island, Illinois, and Waterloo, Iowa. Plants visited were Caterpillar Tractor Company, Keystone Steel and Wire Company, International Harvester Farmall Works, John Deere Plow Works, John Deere Tractor Works, The Concrete Construction Company, and the Clay Equipment Company. W. H. Carter of the agricultural engineering department, accompanied the group. — George Dunkelberg, secretary

# What Is New in Agricultural Engineering

*(Continued from page 216)*

tube orifice meter, having a three-foot throat, was installed at the laboratory and tested.

* * *

A series of experiments to determine the effect of varying degrees of soil moisture in irrigation of pear trees was begun by R. A. Work on a privately owned orchard near Medford, Oregon. The fine sandy loam soil is underlain at a depth of 6 or 7 feet by river wash. The water table is expected to be less than 9 feet during the irrigation season. Eight lined test wells have been installed, a topographic map prepared, an irrigation head ditch laid out, and plots located. Three irrigation treatments will be initiated with moisture conditions of the soil as follows: (a) highly available soil moisture maintained by frequent irrigation; (b) available moisture in all parts of the root zone maintained at all times by irrigation, as required; and (c) soil moisture allowed to be depleted to the point where resultant tree suffering becomes plainly evident by wilting or marked decrease in rate of fruit growth. Intensive sampling will be practiced at 10 locations per plot, each sampled in one-foot increments to the lower depth of the active root zone at 7 to 10-day intervals.

* * *

In connection with the study of evaporation from free water surfaces, A. A. Young installed a tank 2 feet in diameter by 3 feet deep at the Fullerton station in southern California. This is to be shaded by a one-quarter-inch screen or one of different mesh. It is hoped to be able to reduce evaporation from a small tank until it is practically equal to that from the 12-foot tank. If a cheap substitute for the 12-foot tank can be found, it will lower the cost of any future installations. In addition, it may make it possible, through use of shaded tanks at lakes or reservoirs, to obtain evaporation records that more closely approach such losses from large bodies of water.

* * *

Preliminary tests have shown that it is possible to substantially reduce the time required for thinning sugar beets if the seedling stand is very uniform and not too thick, according to S. W. McBirney. Work is being done on a small planter in an attempt to secure seed placement of approximately one seed ball per inch of row. This, it is believed, will give a desirable stand for more rapid thinning.

In connection with the studies relating to turning under rank growing leguminous cover crops, at the farm tillage machinery laboratory at Auburn, Alabama, three sets of attachments have been built for application on existing machines. A universal mounting for tillage tools is under construction. By means of this unit the summation of the linear forces acting on the tillage tool will be measured and the point of intersection of the three right-angled resultants will be located.

* * *

During his work on potato storage at Presque Isle, Maine, A. D. Edgar has obtained shrinkage records of potatoes stored in some 60 bins, with storage periods varying from 4 to 32 weeks. Since the rate of shrinkage is influenced by temperatures and humidity in the bin as well as by length of storage period, it is difficult to determine the separate effect of the various factors. The graphical multiple correlation method developed by L. H. Bean of the Department is being used to analyze the data.

* * *

The use of bottled gas, a heavy, condensed component of natural gas, for both home and industrial purposes, is rapidly increasing in importance. A. H. Senner has recently completed tests of the efficiency and operating characteristics of cook stoves and water heaters for use with bottled gas. These tests were conducted at the laboratory of Johns Hopkins University.

* * *

W. V. Hukill of the Bureau of Agricultural Engineering and R. C. Wright and E. A. Gorman of the Bureau of Plant Industry are making a field study of precooling fruits and vegetables in the market gardening sections of Florida.

* * *

Technical Bulletin 503, "Effect of Gin Saw-Speed and Seed-Roll Density on the Quality and Monetary Value of the Lint and on the Operation of the Gin Stand," by C. A. Bennett and F. L. Gerdes, was issued during the past month.

# What is HIGH

TODAY, leading oil companies in every state are marketing high anti-knock gasolines of uniform quality *at regular price*. So that American farmers may get full advantage of these quality fuels, the tractor industry is now beginning to sell high compression engines designed for 70 octane anti-knock quality gasoline. It is important that all Agricultural Engineers understand this progressive change and the benefits it will give to the farmer.

Here is a simple explanation of the engineering principle of high compression; how it gives more power; why it saves money; how it exposes the fallacy of low grade fuels.

### *Where does the tractor power come from?*

Tractor power comes from heat. You get the heat by burning fuel inside the engine. As it burns, the gases in the cylinders get hotter.

Any gas—like air or steam—tries to expand when it is heated. If it is in a closed chamber, it presses against all walls—trying to escape. The *pressure* goes up. It is this *pressure* inside the cylinders—against the tops of pistons—that turns the crankshafts of all present-day tractors. As the pressure forces the pistons down, the gases get cooler—the heat in them is being turned into power. The higher the pressure is to start with, the more of the heat is changed into power. So higher pressures give MORE POWER to the pistons and leave LESS heat to go out the exhaust as waste.

### *3 ways to get more power*

There are three ways to increase the power of a tractor engine (Automobile engines are the same): (1) Increase the *pressure* of gases against the pistons. (2) Make the engine bigger. (3) Run it faster.

For an engine of fixed size and speed, the only way to increase power is to increase the *pressure* of gases against the pistons.

### *High Compression*

That is what high compression is: *greatly*

# Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, senior agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture.

HEN BATTERIES, *E. W. Callenbach* and *H. C. Knandel*. Pennsylvania Sta. Bul. 314 (1935), pp. 19, fig. 1. This experiment was conducted with four groups of 48 Barred Plymouth Rock pullets each in batteries and with four duplicate groups in pens of a long-type laying house for a 44-week period. The same test was conducted with White Leghorn pullets over a 52-week period.

The pullets in laying houses consumed smaller amounts of mash and greater amounts of scratch grain, and had a greater total feed intake than comparable birds in batteries. Egg production was less variable in the hen battery groups. Total production was greater in batteries with the Barred Rocks, and greater in the laying house with the Leghorns. Fall and winter production was higher in the battery groups, while spring and summer production was higher in the laying house. The method of rearing and managing layers had no effect upon average annual egg weight.

The battery birds weighed more at sexual maturity and at 48 or 52 weeks than the laying-house birds, with the difference being greater in the Barred Rock groups. Recorded egg breakage was higher for the battery groups, especially with the Barred Rocks, but much of the difference was due to the impossibility of recording accurately the egg breakage in floor pens. There was practically no difference in the average percentages of marketable eggs laid by the two groups of Barred Rocks, but the laying-house groups of Leghorns produced more of these eggs than the similar lots in batteries. There was no significant difference in the mortality of the two groups of Barred Rocks, but there was 13.8 per cent greater mortality in the White Leghorns in the laying house.

WOOD STRUCTURAL DESIGN DATA, *I*, computed and arranged by *R. G. Kimbell, A. T. Upson, M. C. Ahern, et al.* Natl. Lumber Mfrs. Assoc., 1935, vol. 1, pp. 296, figs. 74. This volume provides information useful in designing certain types of wood structural members. Sections are included on physical properties of wood; chemical properties of wood; mechanical properties of wood; timber quality-strength relations; glossary of lumber terms; abbreviations of lumber terms; board measure; lumber quantity costs; sizes of American standard yard lumber and timbers; notations and technical symbols; properties of American standard lumber sizes; wood beams, design; wood beams, safe loads, limited by deflection; wood beams, safe loads, determined by bending; wood columns, design; wood columns, safe loads, dressed sizes; wood columns, safe loads, rough sizes; plank and laminated floors, design; plant and laminated floors, safe loads; supplement, working stresses; and decimal equivalents.

THE SHRINKAGE OF WOOD DURING DRYING. Aust. Council Sci. and Indus. Res., Div. Forest Prod., Trade Circ. 23 (1934), pp. 15, figs. 3. Engineering information is given on the shrinkage of wood during drying covering the reason for shrinkage of wood during drying, the difference between radial, tangential, and longitudinal shrinkage, and the resultant effect on the shape of the piece being dried. Data also are given on the variation of shrinkage between species. Apparently it is the removal of combined moisture which causes shrinkage, and this, therefore, involves lowering of the moisture content below the fiber saturation point.

THE COMPARATIVE LIFE, FIRE, AND EXPLOSION HAZARDS OF COMMON REFRIGERANTS, *A. H. Nuckolls*. Underwriters' Labs. Misc. Hazard No. 2375 (1933), pp. 118, figs. 20. These studies were organized to cover both life hazard and fire and explosion hazards, and they are reported in considerable detail. The object of the studies was to afford a practical basis for a comparison of the hazards of refrigerants under similar test conditions.

It was found that sulfur dioxide gas in concentrations of 0.5 to 1 per cent is lethal or produces serious injury on exposure for 5 min, ammonia and methyl bromide in concentrations of 0.5 to 1 per cent are lethal or produce serious injury on exposure for 0.5 hr, methyl formate, chloroform, and carbon tetrachloride in concentrations of 2 to 2.5 per cent are lethal or produce serious injury on exposure for 1 hr, and dichlorethylene, methyl chloride, and ethyl bromide in concentrations of 2 to 2.5 per cent are lethal or produce serious injury on exposure for 2 hr. Two other groups were much less toxic.

Data are presented on the life hazard of refrigerants in the presence of small and large gas flames and oil and wood fires.

A large amount of data is given on the fire and explosion hazards of a number of refrigerants, including ethane, propane, butane, gasoline, methyl formate, illuminating gas, methyl chloride, ethyl chloride, dichlorethylene, ethyl bromide, and ammonia.

FARM BUILDING PLANS, compiled by *H. H. Gordon* and *S. H. Byrne*. Va. Polytech. Inst., (1935), pp. 110, figs. 87. The purpose of this compilation of plans is to provide engineers and building supply dealers with farm building plans for distribution. It has been prepared in cooperation with the USDA Bureau of Agricultural Engineering. Bills of material are given in most cases.

COLLAPSE AND THE RECONDITIONING OF COLLAPSED TIMBER. Aust. Council Sci. and Indus. Res., Div. Forest Prod., Trade Circ. 20 (1934), pp. 22, figs. 8. This is a compilation of engineering information on the reconditioning of collapsed timber.

TIMBER BENDING. Aust. Council Sci. and Indus. Res., Div. Forest Prod., Trade Circ. 22 (1934), pp. 14, figs. 8. The fundamental principles of timber bending are presented in this circular.

THE DESIGN OF OVERHEAD IRRIGATION SYSTEMS, *E. S. West* and *A. Howard*. Aust. Council Sci. and Indus. Res. Pam., 50 (1934), pp. 39, pls. 6, figs. 15. This publication discusses the advantages and disadvantages of overhead irrigation systems as compared with surface methods, and describes a system of spray irrigation in use.

Investigations into the hydraulics of the system are reported and the results discussed. From these investigations formulas which show the relationships between the pressures of water used, discharge from the laterals, and fall in pressure along the laterals, when the constants depending on the friction loss of laterals and discharges from orifices are known, are elaborated.

Engineering data also are included on costs and methods of installation and design. Three appendixes relate to construction of mains, methods used in hydraulic investigations of laterals, and illustrations of the use of the tables of engineering data.

SOIL EROSION CONTROL BY ENGINEERING METHODS, *H. B. Roe* and *J. H. Neal*. Minn. Univ. Agr. Ext. Spec. Bul. 171 (1935), pp. 24, figs. 19. Practical information is given of a technical character for use by engineers in the design and construction of erosion control measures.

It has been found that no part of a terrace grade should exceed 0.4 ft in 100 ft, and the total length of the terrace should never exceed 2,000 ft. None of the terrace slopes should ever be steeper than 1 ft vertical rise to 4 ft horizontal run. Reduction of the grade of gulley floors to 2 ft or less per 100 ft is essential. This is done best by check dams of brush, stone, or concrete laid across the gulley floor.

A MACHINE FOR THE SUBSURFACE TREATMENT OF SOILS WITH CHLOROPICRIN AND WITH CARBON BISULFIDE FOR NEMATODE CONTROL UNDER FIELD CONDITIONS, *J. R. Neller* and *R. V. Allison*. Soil Sci., 40 (1935), no. 2, pp. 173-179, pl. 1. In a contribution from the Florida Everglades Experiment Station a machine is described which is based upon the mole principle and which has been developed in a manner such that chloropicrin and other disinfecting liquids may be applied in a continuous manner beneath the soil surface. The rate of flow is calibrated from the speed of the equipment and the amount of liquid ejected for a unit of time.

THE FEASIBILITY OF USING A HEAT STORAGE DEVICE FOR DOMESTIC HEATING WITH ELECTRICITY, *H. J. Dana* and *R. E. Lyle*. Wash. Engin. Expt. Sta. Bul. 46 (1935), pp. 20, figs. 5. Experiments on the use of a heat-storage device are reported. The device used involved a heat-storage oven filled with granite boulders.

While the results reported are only preliminary, they indicate that so far as the occupants are concerned there was no apparent difference between this type of heating and heating by the hot air furnace. *(Continued on page 230)*

# Agricultural Engineering Digest

*(Continued from page 226)*

COMPARATIVE HEAT LOSS TESTS ON INSULATED BUILDINGS IN THE ELECTRIFIED MASON CITY AT GRAND COULEE DAM SITE, *H. J. Dana* and *R. E. Lyle*. Wash. Engin. Expt. Sta. Bul. 45 (1935), pp. 26, figs. 9. Studies are reported, the purpose of which was to determine the actual average working effectiveness of applying heat insulating material to an uninsulated house. The studies were confined primarily to 3-room houses which were approximately 20 by 28 ft in size, set on concrete piers, and boxed clear to the ground, after which they were banked with earth. The side walls were of 0.75-in sheathing, tar paper, and matched siding. The roof was of 0.75-in ship lap covered with red roofing felt. On the inside all walls and ceiling were finished with 0.5-in wheat straw product insulating material. This material, which comes in large sheets, was nailed to the 2-by-4 studding and ceiling joists, and the joists were covered with thin wooden strips or battens. The floors were of double thickness with tar paper between. There were no basements, and all residences were single story. There was a small space between the ceiling and the roof, with vent louvres in each gable.

Three-wire electrical service to each house provided 120 v for lights and refrigeration, 120-240 v for the electric range, and 240 v for the electric air heaters, and for the water heater. Six different kinds of building insulation were included in the test. The data are presented in graphic form and they indicate the saving of heat which can be accomplished by intelligent insulation.

WOOD HANDBOOK, *R. F. Luxford, G. W. Trayer*, et al. U. S. Dept. Agr., Forest Serv., Forest Prod. Lab., 1935, pp. 326, pls. 6, figs. 64. This handbook contains basic information on wood as a material of construction, together with data for its use in design and specification. Important sections deal with structure of wood; characteristics of some important commercial woods; physical properties of wood; strength values of clear wood and related factors; grades and sizes of lumber; structural timbers; timber fastenings; wood beams, columns, and arches; glued wood construction; bent wood members; control of moisture content and shrinkage of wood; fire resistance of wood construction; painting and finishing wood; protection against wood-destroying organisms; wood preservation; poles, piling, and ties; and thermal insulation.

THE HOLDING POWER OF SPECIAL NAILS, *I. Langlands*. Aust. Council Sci. and Indus. Res. Pam. 46 (1933), pp. 30, pls. 3, figs. 8. In the studies reported in this paper over 4,000 nails, representing 15 types of special nails and 2 makes of plain nails, were tested for static and impact holding power. The relative importance of static and impact holding power is discussed and the methods adopted for determining these values are described. The tests included nails driven into dry wood and pulled immediately and nails driven into dry wood and pulled 3 mo later at a somewhat lower moisture content.

The results showed that the rusted nail had the highest static holding power, while the twisted nails had the highest impact holding power. The static and impact holding powers have been combined to form combined composite figures, which are considered to be the best criterion of the efficiency of the nails under service conditions. The combined composite figures show that the twisted nail made from square wire is superior to all others in all-round efficiency. Next in order is the rusted nail and the twisted nails made from grooved wire. With the exception of the cement-coated twisted nails and a certain type of barbed and cement-coated barbed, the other types of nails showed no significant improvement over the plain nail.

MATHEMATICAL AND EXPERIMENTAL STUDIES ON THE FORM OF CHAFF-CUTTER KNIVES [trans. title], *Y. Tamura*. Nogyodobobku Kenkyu (Jour. Agr. Engin. Soc., Tokyo, Japan), 7 (1935), no. 3, pp. 261-281, figs. 28; eng. abs., p. 281. In a contribution from the Kioto Imperial University, studies are reported in which a new coordinate system of expressing the curve of the edge of the knife of a chaff cutter was developed. Two general forms of spirals for these knives are recommended which are designated as the constant angle type and the constant speed type. The testing apparatus is described.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE WISCONSIN STATION. Wisconsin Sta. Bul. 430 (1935), pp. 58-61, 106-112, figs. 4. The progress results are briefly presented of investigations on soil erosion control which are being conducted in cooperation with the USDA Soil Conservation Service, and on hay harvesting, hay cutting, and feed-grinding machinery.

PUMPS FOR FARM WATER SUPPLY, *C. A. Cameron Brown*. Univ. Oxford, Inst. Res. Agr. Engin., 1934, pp. 42, pls. 4, figs. 6. Engineering information on pumps for farm water supply is presented. The information relates particularly to small electrically driven pumps capable of delivering in the neighborhood of 250 gal per hour.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE PENNSYLVANIA STATION, *A. W. Clyde* and *C. O. Cromer*. Pennsylvania Sta. Bul. 320 (1935), pp. 10, 11, fig. 1. Progress results are briefly presented of studies on rubber tires for tractors, artificial curing of alfalfa, and stop hitches for tractors.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE ILLINOIS STATION. (Illinois Sta. Rpt., 1934), pp. 195-206, figs. 2. The progress results are briefly presented of investigations on the use of electricity in controlling orchard pests, farm home sewage disposal, use of low-grade oils in the tractor engine, use of rubber tires on tractor wheels, new plow attachments for combatting insect pests, terraces and contour farming for reducing soil erosion, harvesting methods, machine for harvesting artichokes, wheat storage, stationary spraying, gas production from farm wastes, and farm poultry structures.

COMPARATIVE EFFICIENCY OF ELECTRICALLY OPERATED TANKS VERSUS ICE IN THE COOLING OF MILK, *J. H. Frandsen*. Jour. Dairy Sci., 18 (1935), no. 7, pp. 479, 480. In a brief contribution from the Massachusetts Experiment Station the results of experiments are briefly reported indicating that the tank should be of ample capacity. Roughly speaking, when filled with cans to full capacity, there should still be room for twice as much water and ice as milk. If the tank is of home construction, there should be at least 3 or 4 in of cork or its equivalent, and this must be protected against moisture. The experiments indicate that the water in the tank should always be as high as the milk line.

STRENGTH AND RELATED PROPERTIES OF WOODS GROWN IN THE UNITED STATES, *L. J. Markwardt* and *T. R. C. Wilson*. U. S. Dept. Agr., Tech. Bul. 479 (1935), pp. 99, figs. 40. This bulletin presents data from a study begun in 1910, involving several hundred thousand tests of the mechanical and some of the related physical properties of 164 species of native woods, together with related information on factors that affect strength properties.

The information given may be used not only for comparing species but also for calculating the strength of wood members, for establishing safe working stresses when used in conjunction with other information including results of tests of structural timbers, and for grouping species into classes of approximately like properties for various purposes. The bulletin is based on the same series of tests but supersedes Bulletin 556, because it covers additional species and additional tests on species previously reported.

In addition to the data from the standard series of tests begun in 1910, there is included results of all earlier tests by the Forest Service that were made in such a manner as to afford data of comparable character to that resulting from the standard series.

REPORT OF THE CHIEF OF THE SOIL CONSERVATION SERVICE, 1935, *H. H. Bennett*. U. S. Dept. Agr., Soil Conserv. Serv. Rpt., 1935, pp. 42. This report, the first of its kind, discusses the history, organization, objectives, and plan of work of the Soil Conservation Service. A section on investigation and research describes the character, status, and progress of investigations on soil erosion, climatic and physiographic studies, watershed and hydrologic studies, and studies of sedimentation and hydraulics.

THE ABNEY LEVEL HANDBOOK, *H. A. Calkins* and *J. B. Yule*. U. S. Dept. Agr., Forest Serv., 1935, pp. III + 44, figs. 27. This instrument is described and illustrated, and technical information and data are given on its use in forest surveying.

SOIL EROSION, ARCHER FIELD STATION, *A. L. Nelson*. Wyoming Sta. Bul. 208 (1935), pp. 35, figs. 18. The investigations reported in this bulletin were conducted in cooperation with the USDA Bureau of Plant Industry.

It was found that soil blowing takes place in damaging amounts, but that most of the productive soils can be farmed without undue damage by soil blowing by using care in practical operations.

Apparently the greatest danger from soil blowing occurs on fallow land generally seeded to winter wheat and on row-cropped land, especially if sandy.

Factors that aid in the control of soil blowing are shallow tillage of a nature that produces clods and leaves the organic matter at the surface, ridging the soil at right angles to the prevailing winds, strip farming, the growing of sod crops, and providing shelter belts or windbreaks.

## Farm Dwelling Construction

*(Continued from page 194)*

first coat for the galvanized steel was a good grade metal primer and the second coat a flat wall paint. All interior woodwork and galvanized steel were given two coats of paint.

*Windows and Doors.* Wood sash, window frames, doors and door frames were used, as well as wood trim and corner boards, in order to maintain a minimum cost.

*Termite Proofing.* Metal termite shields made of 28-gauge, copper-bearing, galvanized steel sheets were provided to prevent all possible passage of termites between the ground and woodwork. Sheets of suitable width were installed, continuing completely around the top of the masonry foundation, including all pillars, supports and piping below the woodwork. These metal strips were firmly inset between the foundation and wood sills, with the projecting edge bent downward at an angle of 45 degrees and extending horizontally about two inches from the face of the foundation.

*Cost.* The cost is substantially the same as the cost of uninsulated frame houses of similar quality of construction. Several studies have been made of comparative costs of steel-clad houses, built on a unit basis, and houses of various types of wooden construction. Under average circumstances, the relationship in cost between wooden construction and metal-clad construction, as established by these studies, should remain practically constant for any floor plan or size of dwelling contemplated. It should be understood that all studies of metal-clad type of construction have considered proper insulation.

For example, one study determined that a four-room bungalow with bath, two porches with concrete floor, all room floors of oak, metal clad inside and outside, metal roof, wallboard for wall insulation and rock wool insulation for ceiling, lighting, and plumbing fixtures included, painting, etc., may be erected complete, including contractor's profit, for $2,675. This is based on material and labor costs in the Birmingham district.

This same house, using wood lath and unpainted plaster for interior walls, wood storm sheathing, and wood drop siding for exterior walls, composition shingles, with all insulation material omitted, is estimated to cost $2,567, a difference of only $108 in cost of the two houses. Therefore, the cost of the wood-frame house, without insulation, is only 4 per cent less than the steel-clad house, properly insulated. By substituting wood sheathing and building paper for the wallboard on the exterior of the studs on the steel clad house, this difference may be reduced to an even smaller amount and satisfactory results may be realized.

Although "steel-clad" construction is definitely competitive in the low-cost field, it is in no respect excluded from other fields, inasmuch as a variety of architectural effects may be produced by ingenuity of design the same as with other building materials.

By retaining the conventional wood frame, it has been proved that a modern farm dwelling may be constructed, incorporating the protective advantages of steel, at a cost low enough to enable the farmer of modest means to build one.

Having utilized unskilled labor in the application of steel sheets in the construction of the demonstration dwelling just described proved that farmers living in remote sections would be able to erect a dwelling of this type with local labor and avoid seeking additional skill elsewhere.



## EMPLOYMENT BULLETIN

**The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.**

### POSITIONS WANTED

AGRICULTURAL ENGINEER looking for work on broader scope. Born and reared on farm. Have agricultural degree and equivalent training and experience in electrical engineering; three years farm management; twelve years in rural electrification and associated work. Minimum salary $3,200. PW-270

AGRICULTURAL ENGINEER, graduate of midwestern state university from four-year course in agriculture, and also four-year course in mechanical engineering, desires a change to a broader field of service. Sixteen years' experience teaching agricultural engineering, including most of its branches, but principally farm power and machinery. Teaching, research, or a combination preferred. PW-271

### POSITIONS OPEN

ENGINEER (preferably agricultural) is offered considerable block of non-assessable stock in a close corporation which controls through strong patents, etc., the manufacture and sale of practical concrete construction specialties of proved utility. This stock can be paid for by development work that need not interfere with the engineer's usual activities. To an ambitious engineer having executive ability, this offers an opportunity to become a high official of a corporation that in due time should become a strong, nationally known firm. PO-112